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EXTRA-ORAL TRACTION IN ORTHODONTICS

By **S. GRANGER McCALLIN**, L.D.S., D.Orth. R.C.S.

REFERENCE to the *Transactions* of our Society shows that Presidential Addresses have been delivered on a wide variety of topics, including the history of the Society, orthodontic politics, research, dental education, clinical theory, and occasionally clinical practice. I would suggest that all my predecessors, and certainly this is so in my case, have had one thing in common, a sense of responsibility to the Society and a desire to make a worthwhile contribution to the advancement of orthodontics on your behalf. What follows is my humble effort in this direction.

As a clinician I have chosen a clinical theme, and it came about as follows:—

About eighteen months ago, one became aware of the fact that more and more children in the Orthodontic Department at the Eastman Dental Hospital were wearing some form of extra-oral harness and that coincident with this, extra-oral procedures were receiving a fair amount of attention in the orthodontic journals. It occurred to me that the reason for this might bear investigation since it was not a technique that had ever acquired much popularity in this country.

With this evening in mind, this matter was given considerable thought, and what follows should be looked upon as an interim report on the indications for the use of the technique and an early assessment of its potentialities. I say "interim report" because it is too early for large numbers of completed cases to have been long enough out of retention for me to be able to show them. But I hope that the material I shall show may prove interesting and that it may stimulate further clinical study.

I have tackled the problem under three main headings:—

1. Why was extra-oral traction being more widely used?

2. Were there some specific types of cases in which it was indicated?

3. Was the technique simple enough, or could it be simplificd so as to make it attractive to both the specialist clinician and the general practitioner orthodontist?

What was the rationale behind the increased use of extra-oral traction? I believe that there are two main reasons. First, it was hoped that directions of dento-alveolar growth might be controlled; and secondly, that in certain cases the extraction of premolars might be avoided.

Most clinicians believe that patterns of skeletal growth vary little after an individual's morphological characteristics become established early in life, and that orthodontic interference produces changes that are largely confined to the dento-alveolar structures. If this is so, is it not logical to attempt to guide the dento-alveolar rise from the bases, which brings the teeth together at a pre-determined occlusal level, into the most favourable relationships possible within the morphological variations inherited by the individual?

So-called normal occlusion is the happy result of the interplay of a delicate state of balance between skeletal and soft-tissue harmony which results in upper and lower teeth coming together into an æsthetically and functionally acceptable interdigitation. It follows from this that if either of these basic characteristics varies from the normal so will a more or less severe malocclusion result.

I reminded you a moment ago that basic patterns of skeletal growth are probably not amenable to modification, but what of soft-tissue patterns? Orthodontists in this country since the war, in seeking to explain the aetiology of malocclusion, have been much preoccupied in understanding the effect of the soft tissues as they invest the developing dento-alveolar structures. Recently, our ideas about inherited variations of soft-tissue morphology and

Presidential Address given at the meeting held on January 9, 1961.

behaviour have undergone a change. Whereas it was thought that these variations were usually of basic aetiological significance, and not amenable to change, we are now beginning to wonder if some of them may not be adaptive to their environment. If this is so, can we not expect some abnormal patterns of activity to re-adapt themselves to a new environment produced by orthodontic therapy? This approach to the soft-tissue problem may account for the apparently higher incidence of lip incompetence in young people. One doubts whether lip incompetence is less prevalent amongst adults; it is just that habitual postures are acquired that mask the basic abnormality. Fortunately for us, many acquired postures help to stabilize partially corrected occlusions. As time goes on, it would appear that skeletal variations are usually of more fundamental importance than soft-tissue abnormalities as aetiological factors.

If soft-tissue adaptation following occlusal correction is possible, as I believe it is, this could mean that it would be an advantage to correct certain types of malocclusion fairly early so that they could develop under more favourable conditions, with possibly some improvement in prognosis.

I have not included any cases that have been treated in the mixed dentition, because large numbers of them have been reported in the literature in recent years.

The reason American workers have employed this technique differs from the one I have suggested since they are not quite so preoccupied with the soft tissues as we are. Many of them, for ideological reasons, are trying to avoid extractions and are quite prepared to retain treated cases for very many years,

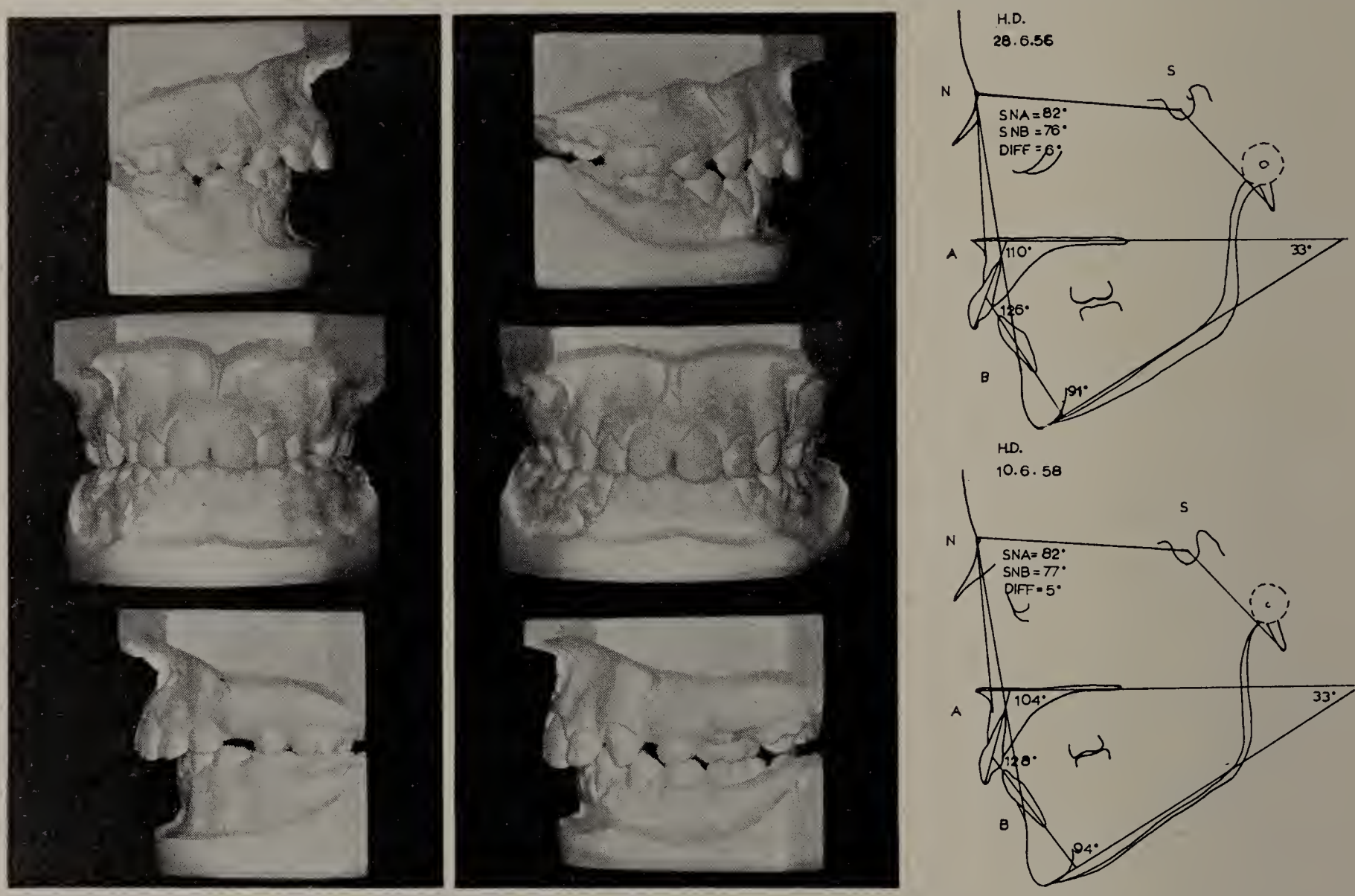


Fig. 1.—A, Models of a girl treated with extraction of both upper first premolars and lower right first premolar; B, Occlusion after twelve months' treatment and six months out of retention. *Note* spacing in maxillary arch from mesial $\underline{4}|$ round to mesial $|\underline{4}$; C, Lateral skull tracings of the original condition and two years later when patient had been out of retention for six months.

which makes it difficult for us to assess the stability of their results.

Let us consider for a moment what could happen when a restraining force is applied to the forward growth of the maxillary dental arch. We know that the maxilla and the mandible grow downwards and forwards away from the base of the skull, and that the forward component of growth is rather greater in the mandible than in the maxilla. We also believe that the relationship between downward and forward growth varies. In this way patients present with very different skeletal forms. Some have long narrow faces with high maxillary–mandibular plane angles, whereas others have short, deep, and wide faces, often with low maxillary–mandibular plane angles. Anteroposterior skeletal growth is relatively less in the former than in the latter. I believe that we shall find that a restraining force applied to inhibit forward growth of the maxillary arch will induce a greater response in those cases where forward growth is relatively greater than downward growth. This requires investigation.

Our difficulty, of course, is that so often we are confronted with cases where neither downward nor forward growth predominates. Crowding in many of these is minimal, but unfortunately mainly confined to the canines and incisors in one or both of the arches. In Class II, division 1 cases there is frequently mild imbrication of the lower incisors with no crowding in the upper arch owing to proclination of the upper labial teeth. In Class II, division 2 cases æsthetics are frequently impaired as the result of quite a small space deficiency with upper laterals overlapping the instanding upper centrals. Again, in Class III cases partially excluded upper canines may be the only occlusal abnormality, but they can be most disfiguring.

Handling this type of problem is the second reason why clinicians have become increasingly interested in extra-oral traction. So often the space needed for reduction of anterior crowding is less than the equivalent of one premolar on either side, and far too many cases are mutilated by extractions which result in poor function owing to tipping of buccal teeth, leaving slack and sometimes open contact points and frequently unsightly residual extraction spaces.

Here is such a case:—

This was a girl (*Fig.* 1) aged 9 years and 4 months in June, 1956. She had a Class II dental base relationship with a maxillary–mandibular plane angle of 33°. There was an overjet and a complete overbite associated with mild lip incompetence. The early loss of the lower right second deciduous molar had been followed by a mesial shift of the lower right first molar and the lower incisors had drifted to the right. The third molars were present.

The treatment prescribed was extraction of both the upper and the lower right first premolars, to be followed by retraction of both upper canines and later the upper labial teeth.

The teeth were extracted in December, 1956, and treatment continued until December, 1957. Records were obtained in June, 1958, when the occlusion had been out of retention for six months.

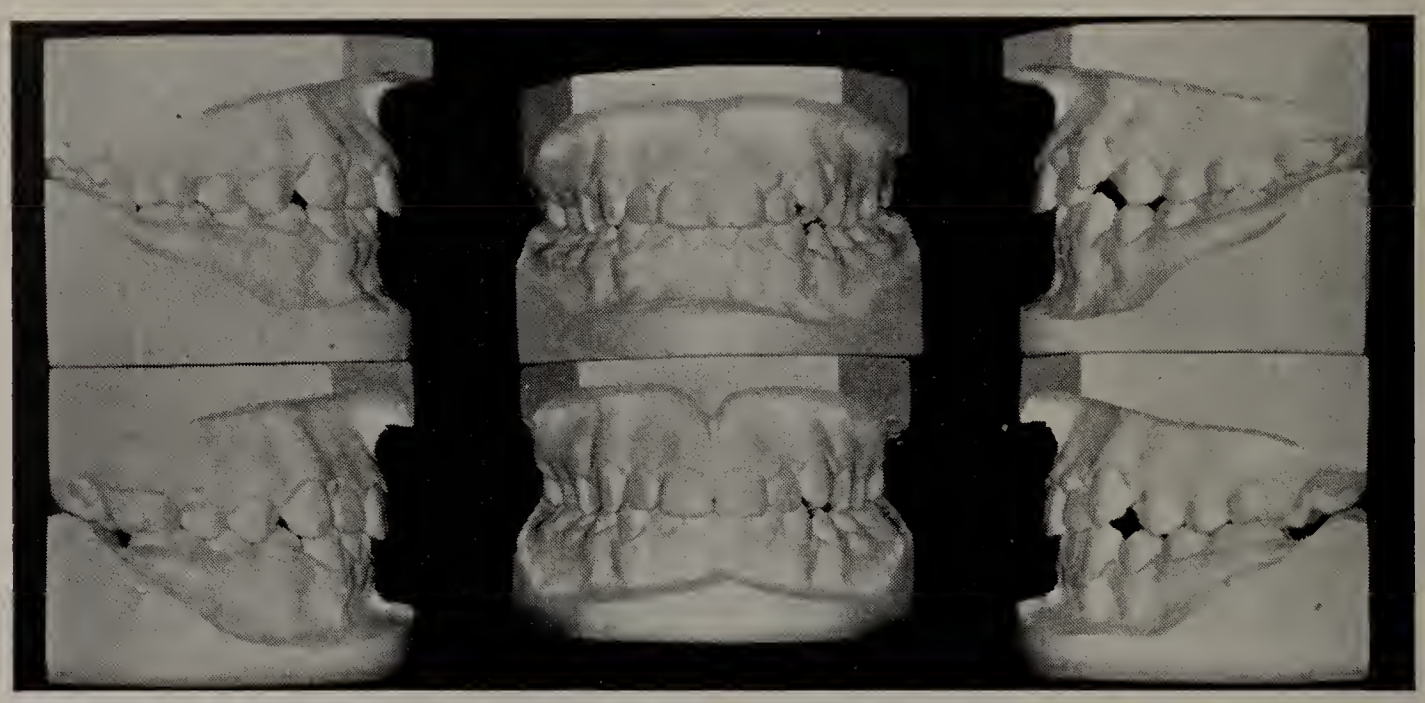
The models (*Fig.* 1 B) show that it had not been possible to close the upper extraction space or to reduce the overjet very much, and that spacing mesial to the upper canines was now present.

The difference between the SNA, SNB angles (*Fig.* 1 C) had reduced one degree.

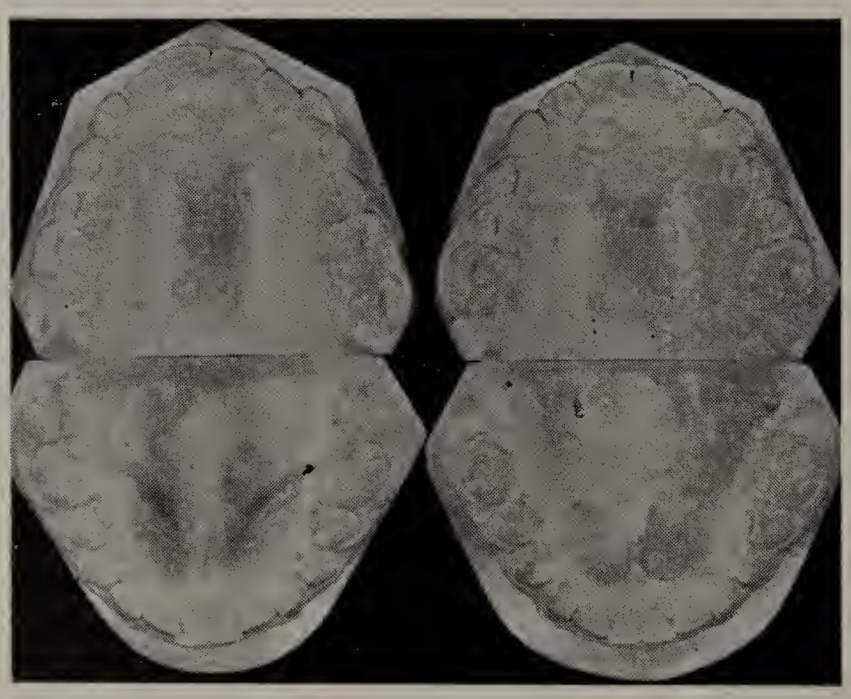
The patient was last seen over two years later in August, 1960, when a clinical note was made to the effect that the upper right premolar extraction space had closed slightly, but the rest of the spaces had remained unchanged. This is quite three years out of retention, and the patient had grown considerably. I would suggest that there was an alternative method of treating this case. If the upper buccal teeth had been retracted, probably with extraction of the upper second molars, much better contact between the upper buccal teeth could have been expected and the overjet could have been reduced at least as much.

I drew attention to the small change in the SNA, SNB angle difference, not because it does not change with extraction of upper first premolars, and reduction of overjets, but because it will be shown that it can change also

with retraction of buccal segments without premolar extractions. Nobody now considers that points A and B are on basal bone; they are, nevertheless, convenient points, which are not too difficult to identify on lateral X-ray plates, that can be used to confirm the matter whether the maxillary teeth are moved backwards or are prevented from moving forwards whilst the mandibular dentition continues to move forwards, so long as one or the other takes place to bring about a re-orientation of the labial and buccal teeth.



A



B

Fig. 2.—A, *Upper models*: A Class I case with mild antero-posterior crowding. *Lower models*: After extra-oral traction to a removable appliance had been worn for three months. Four second molars had been extracted; B, Occlusal view.

reorientation in a vertical plane of the anterior dento-alveolar structures.

I propose to refer to changes in the SNA, SNB angle in the cases that follow just to underline the fact that we are justified in believing that extra-oral traction is an effective restraining force to the forward growth of the maxillary teeth. It does not seem to me to

As I have already said, it is only recently that this technique has been used at all extensively at the Eastman Dental Hospital, and we have relatively few completed cases. Even if we had we would still be faced with the well-recognized problems of making and superimposing tracings from lateral skull head plates. Nevertheless I have one or two cases to show you to give you some idea of the type of changes that can result from the use of this technique.

In *Fig.* 2 A the patient had a Class I malocclusion on Class I dental bases. The lower incisors were inclined lingually in association with lip incompetence. All four buccal segments were forward, and both upper and lower centre lines were slightly to the left. There was partial buccal exclusion of the upper left canine, imbrication of the lower incisors, with impaction of the lower left first premolar. The crowding on the right was minimal and confined to the canines and laterals in both arches. The buccal occlusion was Class I on the right and very slightly Class II on the left. There was a small overjet and a slight increase in the overbite; four large third molars were developing. The caries incidence was low.

Treatment consisted of extraction of all four second molars followed by extra-oral traction to the upper buccal teeth. A removable upper appliance was fitted on Sept. 1, 1960, and reference models were taken again on Dec. 5, 1960, just over three months later.

You will observe a marked improvement in the position of the upper left canine, the partial disimpaction of the lower left first premolar, and a quite considerable reduction in lower incisor crowding (*Fig.* 2 B).

Without treatment following the extraction of the second molars, there might have been a gradual improvement, and this case is shown only to illustrate the speed of response.

I suggest that with extraction of upper first premolars only, it would have been difficult to eliminate the extraction spaces; the upper incisors might have moved apart and lower incisor crowding would almost certainly have increased. It should be mentioned in passing that should lower third molars erupt impacted, distal to lower first molars, following extraction of lower second molars, disimpaction of these teeth by tilting them distally presents no problem.

Fig. 3 shows models of a very similar case, except that this girl, who was 13 years old when first seen, had no third molars. Extra-oral traction was applied to the upper buccal teeth for nine months. The second series of models shows the condition two years out of retention. General skeletal growth was excellent.

Fig. 4 shows the records of a boy aged 15 years exactly in July, 1956. He was diagnosed as having a Class II, division 2 malocclusion on a Class II dental base relationship. The SNA angle was 87° and the SNB angle was 82·5°, a difference of 4·5°. There was crowding of upper incisors with the upper buccal teeth mesially inclined and in contact with the labial segment. There was lower incisor imbrication. The overbite was above average and complete. The molar relationship was Class II on the right and pseudo-Class II on the left. Four unerupted third molars were present.

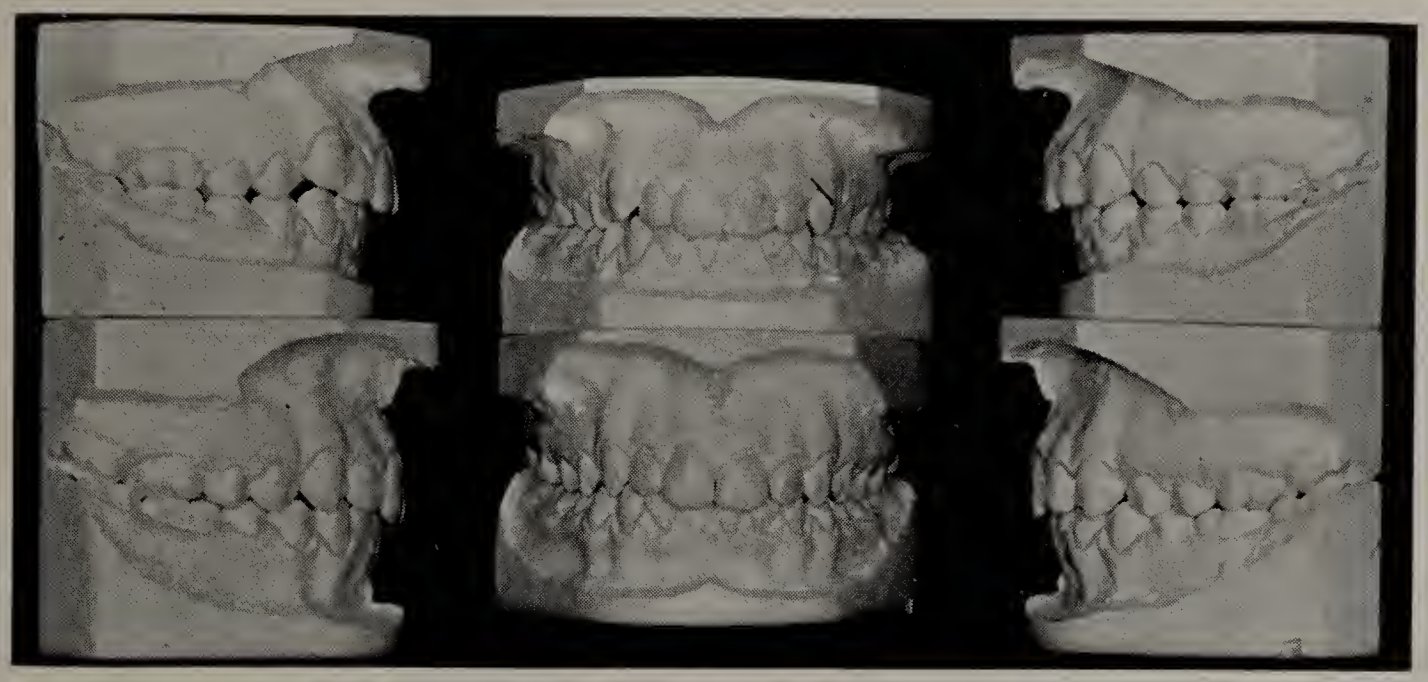


Fig. 3.—*Upper models*: Occlusion of a Class I case where the upper buccal segments were forward relative to the upper labial teeth. The patient had no third molars. *Lower models*: Condition two years out of retention. The upper buccal teeth were moved distally with extra-oral traction to a removable appliance.

The treatment planned was to attempt retraction of the upper buccal teeth with extraction of upper second molars if necessary. Extraction of upper first premolars was contra-indicated since the upper buccal teeth were mesially inclined and space closure might be difficult.

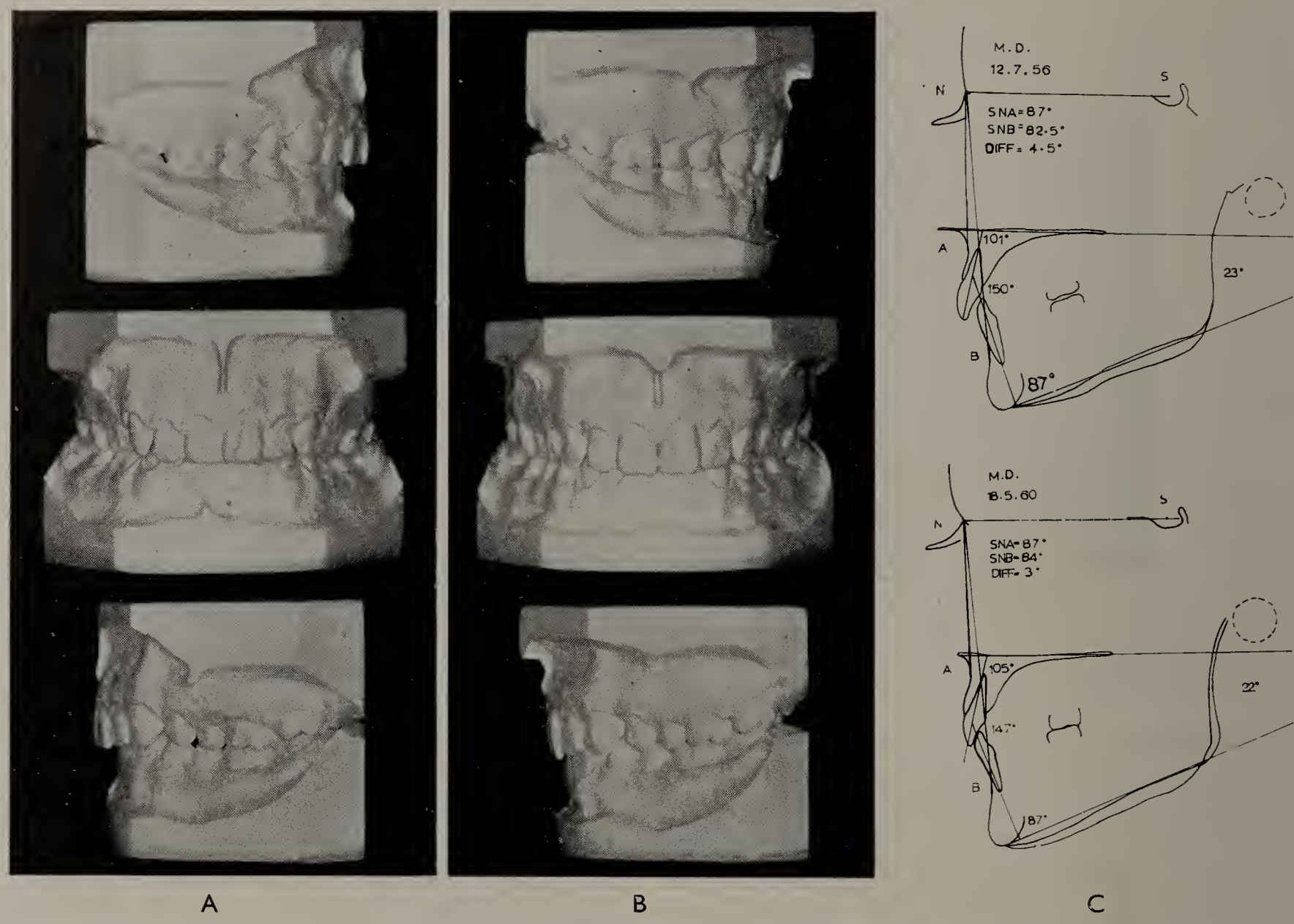
Upper molar bands with a stopped labial extra-oral traction bow were cemented in July, 1956. When upper first molars had been taken back with distal tipping, spacing of the buccal teeth mesial to the molars was closed up with a succession of removable appliances.

A retainer was fitted in November, 1957, sixteen months after commencement of treatment, to hold improved alinement of upper incisors. Retention was discontinued two years later in November, 1959.

Changes produced are shown (*Fig.* 4 B) on records obtained in August, 1960, the case being nine months out of retention. The relationship of the buccal segments had improved, and there had been a small reduction in the overbite with improved alinement of the 1·5°, apparently as a result of the relative forward growth of the mandible.

The next case (*Fig.* 5 A) is of a girl aged $11\frac{1}{2}$ years in March, 1959.

She had a Class II, division 1 malocclusion, with a small overjet and an incomplete and



A B C

Fig. 4.—A, Models of a boy with a Class II, division 2 malocclusion. The mandible was post-normal; B, Occlusion four years later, nine months out of retention. The upper buccal teeth were moved distally with extra-oral traction. No teeth were extracted. C, Lateral X-ray tracings.

upper incisors. The lower incisors were less imbricated than when the boy was first seen. This was rather remarkable and it could mean that the distal movement of the upper buccal teeth had acted as a mild restraint to the forward movement of the lower buccal teeth, as the lower incisor apices had been carried forward with the mandibular growth. It may yet be decided to extract the third molars.

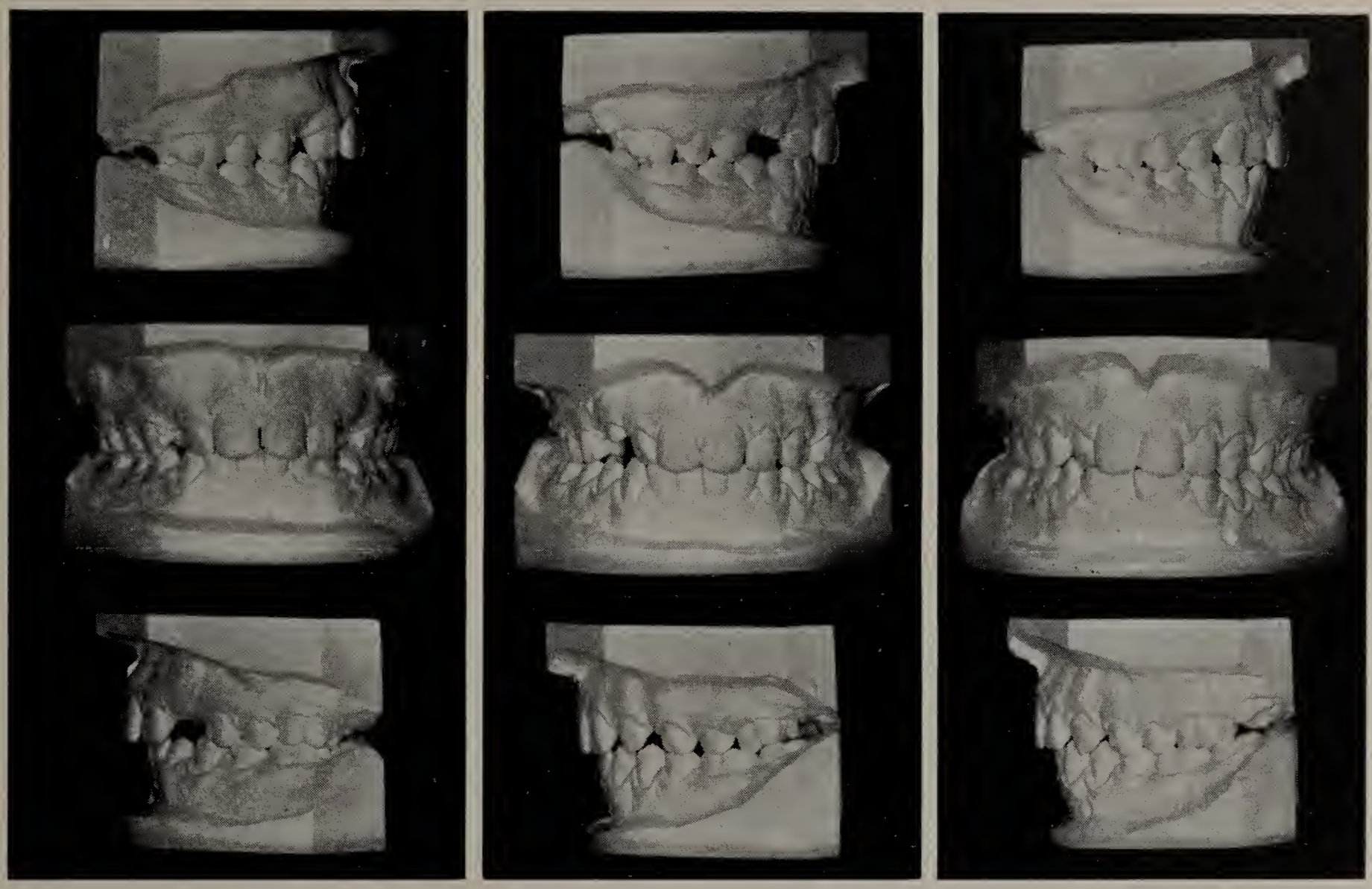
Fig. 4 C shows some of the changes in the angles on the tracings of the lateral skull X-rays. It will be noted that there has been a reduction in the SNA, SNB angle difference of reduced incisor overbite associated with a history of early thumb-sucking and the presence of a mild anterior interdental sigmatism. The dental base relationship was Class II. There was a forward shift of the right upper buccal teeth following loss of the upper right deciduous canine, which had been extracted early to permit the instanding upper right lateral to move labially into better alinement. The upper right first molars had rotated mesiopalatally. The space available for the eruption of the left upper canine was adequate, but would not be so if the overjet was to be reduced. The space for erupting the lower left

canine was inadequate and the lower centre line was just to the left of the upper centre line. This indicated that the lower buccal teeth were developmentally forward relative to the stable position of the lower incisors in the muscle action existing at that time. This muscle action might have been adaptive in character in association with the mild skeletal abnormality and the early thumb-sucking, but was suspect on account of the interdental sigmatism. Caries incidence was low.

Treatment: In view of the tongue activity, prognosis for a reduction of the overjet was possibly rather poor. Therefore, extraction of four premolars to reduce crowding might create space in excess of requirements which could never be eliminated without gross mesial tipping of molars and premolars and an unstable over-retraction of incisors.

In view of this, it was decided to move the upper buccal teeth distally with extraction of second molars from both arches. The fact that the second molars were never extracted, owing to a misunderstanding, has resulted in some interesting occlusal changes.

A stopped labial arch against bands on upper first molars was fitted in March, 1959, with extra-oral attachments, and this was worn, followed by a removable upper appliance to take the upper right premolars distally, until December, 1959, when appliances were abandoned since more than enough space was available for the upper canines.



A B C

Fig. 5.—A, Models of a girl with Class II, division 1 malocclusion. The mandible was post-normal. B, Models after nine months' treatment with extra-oral traction. C, Models nine months after treatment had been discontinued.

The models in *Fig.* 5 B illustrate the condition at that time. You will observe that the buccal teeth had been over-retracted, that the upper right lateral had drifted lingual to the lower teeth, and that the overjet had been partially reduced. The upper right second molar was just beginning to erupt. The upper and lower centre lines were now coincident, the lower left canine having completed eruption.

The patient was seen in May, 1960, when little change was observed, and again in

October, nine months out of retention, when some detailed changes were recorded (*Fig.* 5 C).

You will appreciate that space for the upper right canine and lateral was not quite adequate and the lateral had remained palatally placed just lingual to the lower lateral. The lower incisors were imbricating with the right lateral moving labially, and the lower centre was moving across to the right of the upper centre. The overjet was less than it had been originally, into the floor of the mouth and caused proclination of the lower incisors.

Although this case is not finished I expect a satisfactory outcome which I do not consider we could have achieved with extraction of upper premolars, because of the probability of spacing of the upper incisors, mesial tipping of the upper buccal teeth, difficulty with elimination of extraction spaces, and increased crowding in the lower arch.

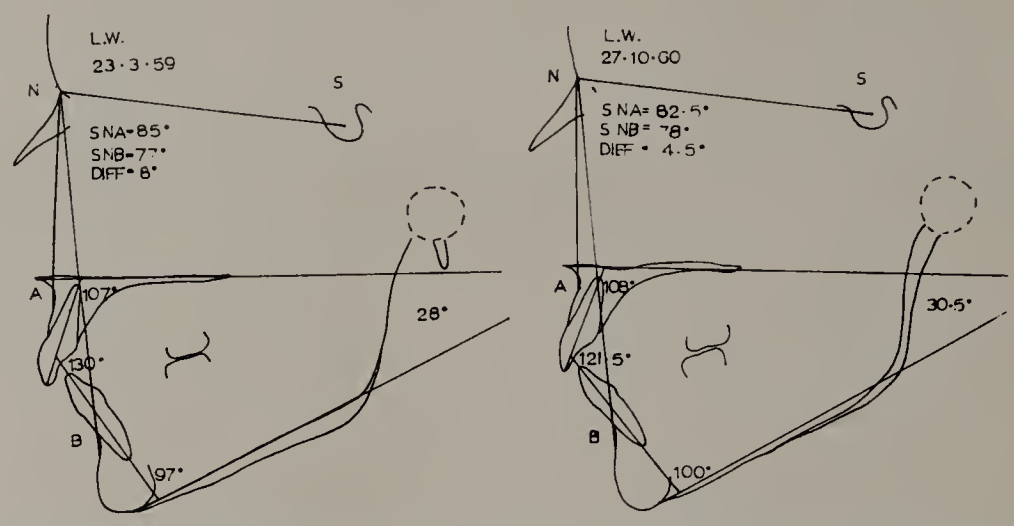


Fig. 6.—Tracings from lateral X-rays of case shown in *Fig.* 5. These show dento-alveolar re-orientation following extra-oral traction to maxillary arch.

and the overbite had also been fractionally reduced. All four second molars had erupted. Owing to faulty appliance manipulation, the upper right first molar had moved palatally into cross-bite with the lower right first molar.

The patient has now been referred for extraction of all second molars, but treatment to date illustrates several interesting points.

Again (*Fig.* 6), the SNA, SNB angle was reduced, this time by 3·5°, largely as the result of a relative distal movement of the maxillary dentition, but in this case there had been much less forward movement of the mandibular dentition as a whole, whereas the lower incisors appear to have proclined. The overbite and overjet have been reduced slightly, with the proclination of the lower incisors. If the upper incisors have moved back they must have done so bodily. I suggest that while the upper buccal teeth were free to respond by moving distally, the incisors were controlled by the unfavourable tongue activity. As the upper incisors were held by the removable appliances used to retract the upper right premolars, the tongue was forced

In the last case (*Fig.* 7 A) there are some features not unlike the previous one. These are records of a girl aged $12\frac{1}{4}$ years in March, 1958.

Her dental base relationship was Class II. The occlusion was Class II, division 1. The lips were incompetent, and to obtain an anterior oral seal the tongue was thrust forward to contact the contracted lips. The upper buccal teeth had drifted forward to maintain contact with the proclined upper labial segment. The overbite was incomplete, associated with the tongue action which was thought to be adaptive in type. The upper left central and lateral were rotated. There was no speech abnormality. All third molars were developing.

Treatment prescribed was distal movement of the upper buccal teeth with extraction of the upper second molars to correct the buccal occlusion and to provide space into which to reduce the overjet with reduction of incisor rotations. The extraction of premolars was contra-indicated in case a stable reduction of the overjet proved to be impossible in association with the muscle activity.

Treatment was started in April, 1958, using very light Class II intermaxillary traction from a removable lower traction appliance, which carried spurs to prevent the over-eruption of the lower second molars, to a Johnson twin-wire apparatus in the upper arch. There were compression coils on the end tubes of the upper appliance activated to move the upper first molars distally. Extra-oral pressure was applied to the anterior ends of the end tubes by hooking the extra-oral traction on to the inter-maxillary traction hooks on the twin arch. The inter-maxillary traction was worn for 10 hours out of 24 and the extra-oral only for the remaining 14 hours.

After twelve months, in April, 1959 (*Fig.* 7 B), the buccal occlusion had been corrected and the overjet and the rotations of the upper incisors had been reduced, as their crowns had been tipped back with forward movement of their apices. Lateral tracings (*Fig.* 8) suggest that there had been some forward movement of the lower arch, while in the upper the lack of change in the SNA angle is probably due to the forward movement of the upper incisor apices. The difference between the SNA, SNB angle was now 4° instead of the original 5·5°.

At this time, the lower appliance was discarded and a removable upper retainer was fitted which was not stabilized with extra-oral traction. This was worn for ten months and then discarded.

The most recent records (*Fig.* 7 C) were obtained in October, 1960, eight months out of retention. It will be noticed that there has been a partial return of the overjet, but little deterioration in the buccal occlusion. There is slight spacing in the upper labial segment and distal to the upper left canine. The overbite is still incomplete.

The muscle patterns (*Fig.* 9) were unchanged except that the degree of lip incompetence appeared to be slightly less severe and there was a tendency for the lower lip to function in front of the upper incisors in maintaining an anterior oral seal.

With further development, one would anticipate that the soft-tissue patterns will become more favourable, and with no pressure behind from the upper buccal segments it would be surprising if the overjet were not reduced to some extent. It might have been better if the retainer had been stabilized with extra-oral traction. The case is being kept under observation.

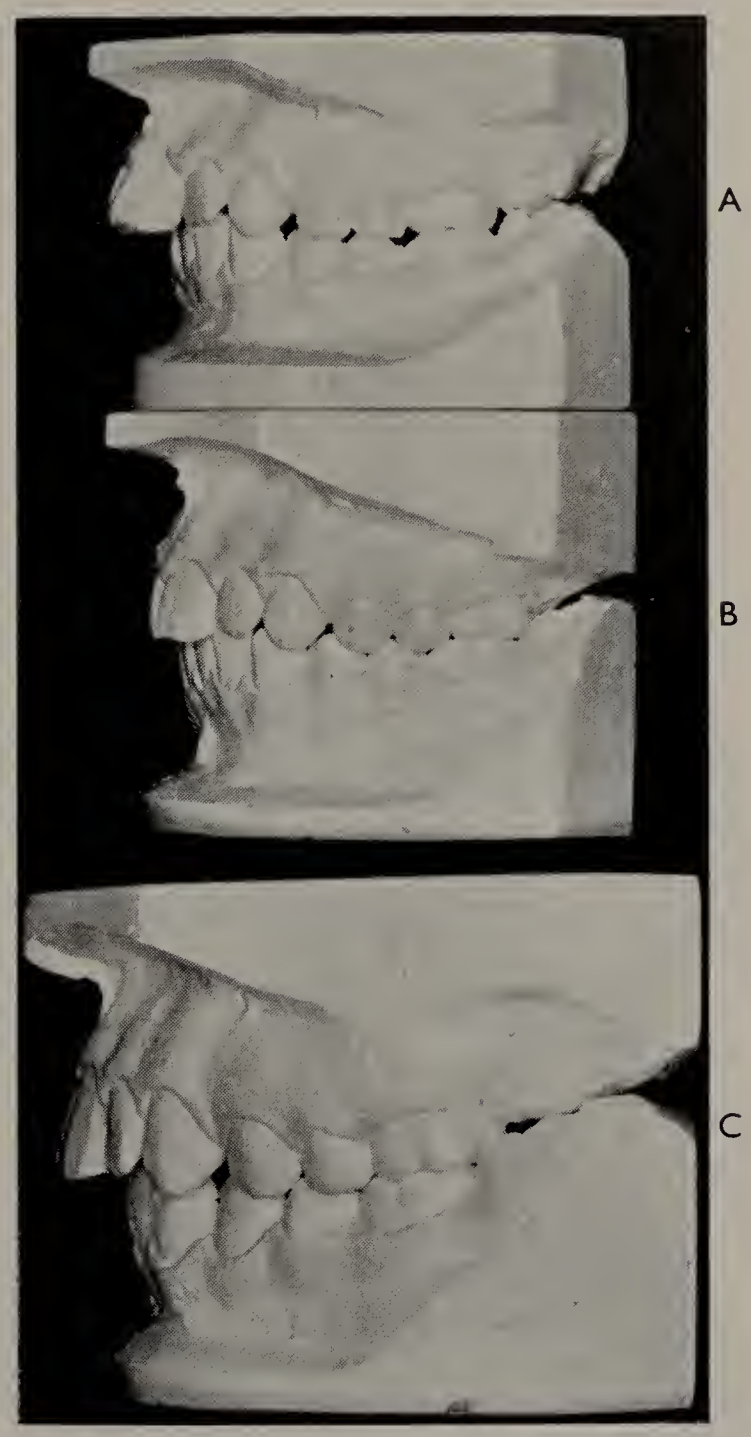


Fig. 7.—Models of a girl with a Class II, division 1 malocclusion. The mandible was post-normal. A, Before treatment; B, After treatment; C, Eight months out of retention.

Very light Class II inter-maxillary traction had been used to supplement extra-oral traction to the maxillary arch. $\underline{7|7}$ had been extracted.

I hope that you will agree that these cases have served to illustrate that extra-oral traction alone, or in association with other types of therapy, has benefited these patients. The fact that none of the cases is truly finished does not seem to me to matter. Re-orientation of opposing teeth and arches has been effected and tooth movements of this

type must be of value in many cases, with widely differing morphological features.

This brings me to my second main heading, namely, What are the indications for the use

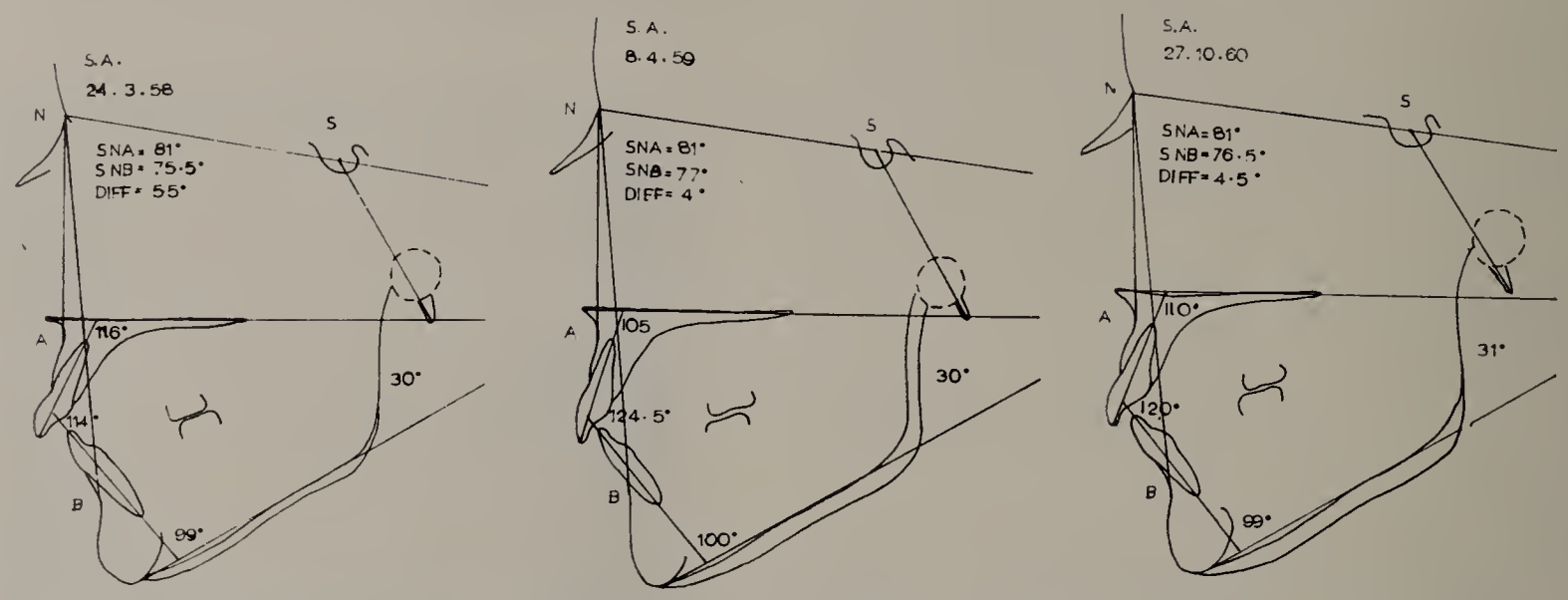


Fig. 8.—Tracings of lateral X-rays of case shown in *Fig.* 7. Tracings on right show occlusion eight months out of retention.

Fig. 9.—Photographs of patient shown in *Figs.* 7 and 8.

of extra-oral traction either alone or as a supplcmentary force ?

I suggest, as I mentioned earlier, that this type of therapy should be considered in mild examples of Class I, II, and III malocclusions. This is particularly so when there has been very little or no mutilation of the archcs due to the premature extraction of deciduous teeth. In other words, where the extraction of premolars will create space in excess of requirements that could only be managed with complex techniques.

One important contra-indication to the use of this technique is in cases with considerable lower incisor crowding which is almost invariably associated with the lower buccal teeth being forward on the base. When this is the case, correction of the buccal occlusion by distal movement of the upper buccal teeth will not result in their being taken far enough back to permit a reduction of a mild overjet or upper incisor crowding. Occasionally, where caries incidence is low and the status of the first molars is satisfactory, this difficulty can be overcome with extraction of lower second molars. Obviously the presence of third molars must be confirmed and they should not be lying at grossly unfavourable angles. It is well known that lower incisor crowding can be reduced with extraction of second molars, often with no appliances, but I would caution against wholesale extraction of second molars from the lower where there is the slightest doubt about prognosis for the first molars.

Always keeping in mind this point about the position of the lower buccal teeth on the base and relative to the lower incisors, we can pass on to some specific types of cases in each occlusal group where extra-oral traction to the upper arch is indicated.

Class I.—All cases where the lower arch alinement is good and the malocclusion is confined to mild crowding of the upper incisors, or partial exclusion of mesially inclined upper canines without incisor crowding. If upper first molars are distally inclined, the technique is contra-indicated since this is an indication of a degree of anteroposterior base deficiency. If, however, the first molars are mesially inclined, extra-oral traction should be considered. I am taking it as read that third molars must be present and favourable, both as to size and position. There are large numbers of Class I cases of this type especially associated with mild Class II skeletal patterns.

Class II, Division 1.—All cases where the lower arch alinement is good and the overjet is mild, especially those where the upper buccal teeth are mesially inclined and a reduction of the overjet will position the upper incisors inside lower lip activity.

The technique, working in association with other apparatus—for example, part-time Class II inter-maxillary traction—is especially valuable where tongue activity against a lower lip is holding upper incisors proclined and the lower incisors down to maintain an incomplete overbite. One is frequently afraid in this type of case that closure of premolar extraction spaces may be difficult, if not impossible. The technique has not proved effective in these cases working alone, since a continuous 24-hour pressure is necessary to reduce an overjet maintained by tongue thrusting. If such a tongue thrust is associated with a speech defect, prognosis is always bad unless the speech abnormality is of a type that will improve with age, when this technique will probably be as effective as any other.

The early treatment of quite severe Class II, division 1 cases in the mixed dentition stage is worth considering. Many cases treated at this stage of development have been reported in American journals, and when mild soft-tissue abnormalities are associated with these, it may be an advantage to correct the occlusion early. We have a number of cases of this type under treatment at the Eastman Dental Hospital at this time, but it will be a few years before we can assess for ourselves the true value of this type of interference at this age.

Class II, Division 2.—These cases fall into two main groups: those with lower arch crowding and those without. The former are always difficult to treat with any technique, and prognosis is usually poor, but many of the latter respond readily to extra-oral traction. Again, those with distally inclined upper first molars should be treated with the extraction of premolars, but many of these cases have buccal teeth mesially inclined and these can usually be taken distally.

Class III.—In so many of these cases, one is loath to extract upper first premolars because the loss of these teeth removes buccal support from the upper labial segment, rendering the incisors vulnerable to palatal collapse if residual space cannot be completely eliminated. There are large numbers of Class III cases where a patient is able to eliminate a reverse overjet by retracting the mandible to bring the occlusal tips of the upper and lower incisors into contact. If the crowding in the maxilla is not too severe and the lower buccal teeth are forward in contact with the labial teeth, these cases will respond well to the extraction of upper second molars and lower first premolars, followed by slight proclination of the upper incisors and extra-oral traction for distal movement of the buccal teeth. Frequently, no appliances are necessary in the lower.

There are other uses for the technique that are worth considering:—

1. It can often be used effectively for the retraction of maxillary teeth in patients who adopt a habitual forward posture to obtain an anterior oral seal because of the presence of a mild overjet. Class II inter-maxillary traction is sometimes unavailing in correcting this type of Class II, division 1 case, since the patient postures forward as soon as the inter-maxillary elastics are hooked up, and reciprocal pressure is therefore reduced.

2. As an anchorage reinforcement in association with inter- or intra-maxillary traction mechanics, extra-oral traction can frequently just tip the scales towards a

favourable outcome in a case that would otherwise fail. Some of my colleagues are unkind cnough to call this my "belt and braces" approach to treatment, but I am

Fig. 10.—Extra-oral "whiskers", 1·25-mm. wire, attached to a labial 0·9-mm. wire which stands away from the incisors.

quite unrepentant, having found it most valuable in association with many types of appliances.

3. Retcntion of certain types of cases does sometimes present a problem when an overjet is associated with tongue thrusting activities, which tend to move retracted upper incisors forward. These can often be retained with extra-oral traction applied to the upper retainer, which will resist forward pressure of a tongue thrust of this type so that a reduced overjet is held while tongue action is given a chance to become modified. Obviously the effects of an endogenous tongue thrust cannot be controlled in this way; but where the muscle activity is adaptive in type, this procedure is sometimes helpful.

This brings me finally to a few words about the technique itself. You will remember that I said earlier that one of the great advantages of extra-oral traction was that the procedures were simple and well within the capabilities of general practitioners who do not have the time to acquire a high degree of appliance expertise.

The secrct of success lies in the design of the appliance and its extra-oral components which must be easy for the patient to manage and tolerate. Generally spcaking, if a clinician can show that he is confident that the apparatus he is fitting will work, some of this confidence will be transferred to the patient, and, so long as the apparatus is not uncomfortable, co-operation can be expected. I suggest that one of the main reasons why this technique has not been popular in the past is because the headcap or cervical harness has been tedious to make, uncomfortable to wear, and liable to become unhooked. This has led to a high incidence of non-co-operation and a lack of enthusiasm on the part of the clinician.

For the past two years I have been using a removable appliance (*Fig.* 10) with extra-oral "whiskers" of 1·5-mm. wire attached to a 0·9-mm. labial bow which stands away from the upper incisors. Incorporated in the appliance (*Fig.* 11) is a 1·25-mm. expansion Coffin spring, and where necessary a flat anterior bite-plane. The appliance is activated by pinching the reverse bends on the bow, which stands the bow away from the incisors and opens the anterior part of the palatal plastic. The heels of the appliance are then just pulled wider apart so that the division between the two halves remains parallel. This will expand the buccal teeth just enough to permit them to move distally and remain correctly related bucco-lingually to the lower teeth. I have found that this method of attaching the extra-oral "whiskers" on to the labial bow instead of inserting it into tubes on the buccal clasps is more rigid and overcomes the tendency for the clasps to become distorted with loss of appliance anchorage.

The cervical strap is exceedingly simple, being made of 1-in. wide terylene petersham which is folded back on itself and sewn round the edges, except right in the middle, so that the anterior end of the traction hook can be forced through the anterior end of the strap. The posterior end of a No. 8 elastic is knotted through itself at the apex of the triangular piece of 1·25-mm. wire, which has been forced through the strap near the edge and passed over the open end of the diamond anteriorly. The triangle, which is half an inch from the centre at the back, is an improvement on a

hook sewn in the middle because it holds the strap flat and prevents it from rolling up into a string, which is uncomfortable.

The diamond prevents twisting and rolling of the traction hook. The "whisker" hooks are bent in the vertical plane and the traction hooks in the horizontal plane. One rubber

The "whiskers" are then adapted to the face and turned back in a vertical plane in front of the mark.

A prefabricated strap is selected which will end a little short of the mark on both sides when passed round the neck and pulled firmly forward. The traction hooks which have

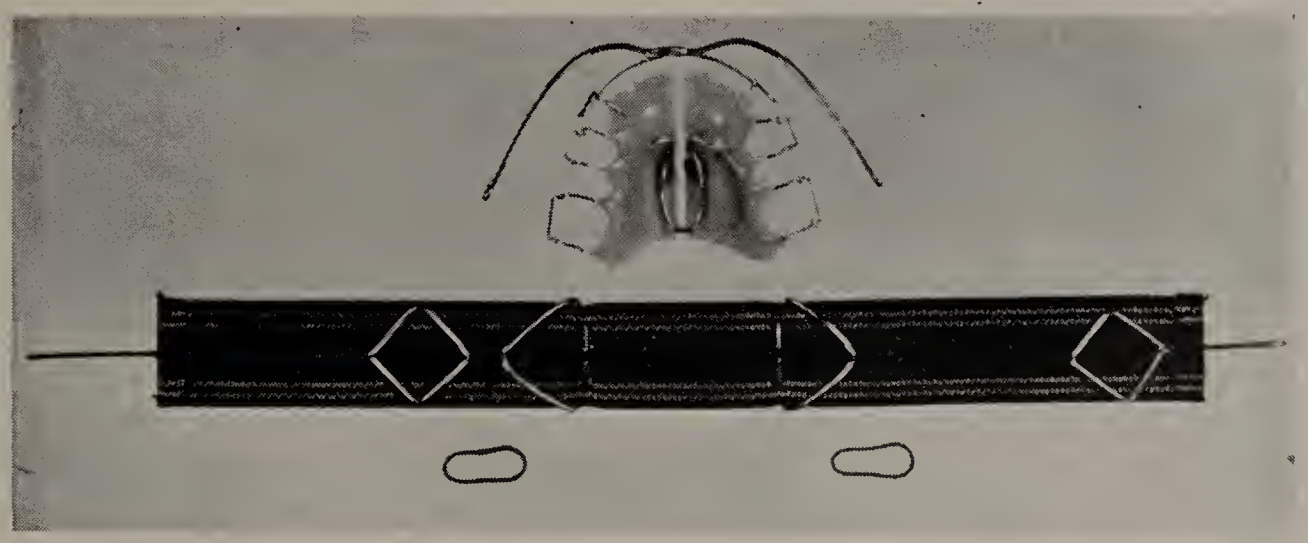


Fig. 11.—Palatal view of appliance shown in *Fig.* 10 with cervical harness. Palatal Coffin spring 1·25-mm. wire. All wire attached to harness is of 1·25-mm. gauge. The strap is made of 1-in. wide terylene petersham.

Fig. 12.—Shows sequence of operations for fitting the appliance. A, Face marked for selection of strap of suitable length; B, Suitable strap selected; C, "Whisker" marked just in front of mark on face; D, "Whisker" turned back on itself to form a hook in the vertical plane. The hook coming forward through the strap flap is bent back on itself in the horizontal plane.

each side is adequate and should probably not be exceeded.

The sequence of events for fitting the appliance is as follows:—

The clasps are adjusted for anchorage, the appliance is expanded very slightly, and the labial bow, which is stood away from the incisors, is adjusted to the correct level for the lip line.

The patient's face is then marked just behind an imaginary line dropped vertically from slightly behind the outer canthus of the eye on both sides (*Fig.* 12).

been prefabricated so that they project about 1 in. in front of the strap are then hooked over the "whiskers" with the rubbers attached.

The traction hooks are bent slightly at the appropriate point to allow them to pass round the posterior border of the mandible.

Lastly, the "whiskers" are adapted to lie close to the face, but not too close to the corners of the mouth so that saliva will become trapped, which can lead to soreness.

You will note that the "whiskers" come out of the mouth at the closed lip line to prevent

the upper or lower lip displacing them as the lips are approximated.

An assistant or a technician can make up a supply of straps which I keep in lengths of $8\frac{1}{2}$ in. increasing by half-inches up to $11\frac{1}{2}$ in.

Fig. 13.—Extra-oral gear used in association with the twin wire arch technique. Labial bow inserted into the lower of two tubes attached to buccal of first molar bands.

These will cover nine-tenths of the cases. Just to be sure that I shall have one available I select the correct strap when I take the impression for the appliance.

Instructions to the patient are: "If you cannot manage to sleep with it the first night don't worry, but keep trying until you can." The appliance should be worn for 10 or if possible 12 hours in 24.

One would expect to see a response in four weeks, and then the patient can be seen at 6 weekly intervals.

This same harness can be fitted on to "whiskers" attached to a stopped 1-mm. labial bow in buccal tubes on upper first molar bands. This is useful in the mixed dentition.

It is also possible to use the technique in association with other types of fixed appliances (*Fig.* 13) by inserting the labial bow in the lower tube of a double-tube attachment on the buccal of upper first molar bands. With extraction of upper second molars, it is often possible to retract the buccal teeth as incisor crowding and rotations are reduced.

Finally, if the "whiskers" are lined up below the level of the labial arch, the first molars will be tipped back—if above the level of the arch the first molar apices will be moved back. When used with a removable appliance one usually lines them up just above the level of the clasps. If you are dealing with a mutilated post-normality and only want one side to go back, the "whisker" on the affected side should be longer than on the side where you do not require distal movement. It is remarkable how effective this is. There is no need to attach "whiskers" anywhere but in the middle of the labial bow.

My treatment of this subject has of necessity been brief, and, I am well aware, somewhat superficial, but I hope it will have stimulated an interest in the potentialities of this technique.

My grateful thanks are due to members of the Orthodontic Department at the Eastman Dental Hospital for allowing me to show their cases, to our clinical secretaries for typing the script, to Mrs. F. Hale for reproducing the tracings of the lateral skull X-rays, and to the Photographic Department for the preparation of the illustrations.

Mr. K. E. Pringle, in moving a vote of thanks to the President, said that he was sure that Mr. McCallin would bring to his office the elegance and good sense for which he was so well known to them all. To be the President of the British Society for the Study of Orthodontics was, for an Englishman, an acknowledgement of the high respect in which he was held by his colleagues. He knew that in the coming year their President wished the practice of orthodontics to be well to the fore. Their programme indicated that this would be so. The President's Address, to which they had all listened with very great interest—it was for many of them a new approach—also showed the practical turn.

He wished to assure the President that they all hoped he would have a very happy year of office.

SUPERNUMERARY TEETH

By **J. H. GARDINER**, B.D.S., D.Orth. R.C.S. (Eng.)
Senior Lecturer and Head of the Orthodontic Department, Sheffield Dental School

SUPERNUMERARY teeth are commonplace, for, as early as 1771, John Hunter stated: "We often meet with supernumerary teeth, and this, as well as some other variations, happens oftener in the upper than in the lower jaw", and it must be the experience of most who practise children's dentistry. Desirabode (1847) reports the case of a servant of a physician to the Hôtel Dieu who had over forty teeth in all. Bellinghausen (1955) more recently describes a patient having over thirty supernumerary teeth. Teeth extra to the normal complement have been found in the earliest remains of man (Weinberger, 1926) and have been recorded in dental literature since the days of Paul of Aegina in the seventh century A.D. Over fifty cases were recorded in dental literature between 1850 and 1900, and in the last ten years over thirty cases have been published, but these, naturally, only represent a fraction of the cases presenting for treatment.

FORM

"The form of supernumerary [teeth] is very different from that of any of the other classes of teeth", was stated by Joseph Fox in 1803, and his description of these extra teeth could well be repeated to-day: "they are generally small round teeth resembling the point of a quill, and sometimes they are not much unlike bicuspis of the under jaw". Blake (1801) also describes "the bodies and roots of the lateral temporary incisors and cuspidati joined together", and "the middle and lateral incisors were so intimately united that on viewing them externally they appeared as one large middle incisor"; also "I have sometimes observed a supernumerary tooth, firmly attached to a grinder".

There is no doubt that it is the appearance of some of these supernumerary incisors, or their sequelæ, that cause some patients to seek treatment.

TERMINOLOGY

Tomes (1897) suggested that these supernumerary teeth resembling normal teeth be called "supplemental teeth". An idea of their incidence is given by the fact that out of 100 cases of extra teeth treated at the Sheffield Dental Hospital, 23 had what Tomes would call supplemental teeth, 74 had the conical or multicuspid form, and 3 cases had both supplemental and supernumerary teeth. Bolk (1914) gives the name "mesiodens" to a supernumerary tooth occurring in the upper midline, "paramolar" to those occurring in the interproximal space buccal to the upper second and third molars, and "distomolar" to any fourth molar lying either directly distal or disto-lingual to the upper third molar.

INCIDENCE

The incidence of the separate supernumerary teeth appears to be constant. MacPhee (1935), in a visual examination of 4000 Glasgow schoolchildren, discovered 12 *erupted* supernumerary teeth—an incidence of 0·3 per cent.

Dolder (1936), in 10,000 Swiss schoolchildren, found a similar incidence, as also did Tinn (1940) in 8500 Yorkshire schoolchildren. In 1000 Sheffield schoolchildren (Gardiner, 1956) a similar incidence of erupted supernumerary teeth was found, and Stafne (1932) also gives the same figure for erupted supernumeraries, but, having made a full-mouth radiographic examination of 48,550 persons, he found that the *total* incidence (i.e., both erupted and unerupted) was nearer 1 per cent. As regards the incidence of cases actually presenting for treatment in a Dental Hospital,

Given at the meeting held on February 13, 1961.

we have found in Sheffield that, taken over a 10-year period, out of a total of 2250 patients treated for malocclusion, 100 or $4\frac{1}{2}$ per cent had extra teeth.

In certain conditions the incidence of extra teeth is much higher, e.g., in 60 cases of cleft palate Millhon and Stafne (1941) found the incidence of supernumerary teeth to be 37 per cent, and in 40 orthodontic patients having cleft palates in Sheffield the incidence was 42 per cent. There also appears to be a higher incidence in patients having cleidocranial dysostosis (Payne, 1930; Chipps, 1951; and Brash, 1956).

COMPARATIVE ANATOMY

Bateson (1892) from his study of 3000 animal skulls found extra teeth to occur more frequently in domestic dogs, anthropoid apes, and seals, and Hübner (1930) observed that monkeys frequently have four molars, whereas they only rarely have extra anterior teeth and almost never any extra premolars.

SITUATION

As regards the situation of extra teeth in humans, Stafne (1932), in his very complete study, found the distribution of supernumerary teeth in persons who were mostly adult to be as shown in *Table I.*

Six of the Sheffield patients were found to have inverted supernumeraries, but Stafne found that 114 out of 200 supernumerary teeth in this region were inverted, i.e., their crown directed towards the nares, and 4 cases are reported where the extra tooth has, in fact, erupted into the nasal cavity. These inverted supernumerary teeth appear to have a more definite canine-like crown than the conical mesiodens. In the adults especially, there was evidence of the decalcification and *absorption* of these inverted supernumerary teeth, i.e., in 24 of Stafne's patients and 4 of Morgan's 50 adult patients. Flint (1939) claims that their decalcification does not occur under 35 years of age. Also 10 of Stafne's patients and 12 of Morgan's adult patients had cystic conditions associated with the supernumerary teeth.

In the lower central incisor region of all 10 cases Stafne found the extra teeth to be supplemental incisors, i.e., resembling normal central incisors, but in Sheffield the proportion was found to be higher, i.e., 3 supplementary lower centrals out of a total of 100 cases. Conical supernumeraries do, however, occur in this region (Stones, 1954).

Stafne also found, in the upper lateral incisor region, the extra teeth to be supplemental teeth resembling normal incisors.

Table I.—Stafne's Figures on the Incidence and Distribution of 500 Supernumerary Teeth

	Central Incisors	Lateral Incisors	Canines	Premolars	Paramolars	Fourth Molars	Total
Maxilla	227	19	2	9	58	131	446
Mandible	10	0	1	33	0	10	54

The upper incisor region of the mouth has the highest incidence of supernumerary teeth and the majority are the simple conical mesiodens. These very often occur in pairs, e.g., in 20 of Stafne's 180 patients, in 42 of Morgan's (1946) 100 patients, and in 20 of the 100 Sheffield patients. In only a proportion of cases are the supernumeraries *erupted*, e.g., 21 of Stafne's 180 patients and 18 of Morgan's 100 patients.

Other observers report the same (Munro, 1952; Townend, 1953; and Brown, 1954), each of these latter cases having been preceded by supplemental deciduous lateral incisors. In Sheffield, out of 25 patients presenting with supplemental teeth 18 occurred in this upper lateral incisor region and 4 were known to have been preceded by supplemental deciduous laterals. Stafne did not report finding any extra teeth in the lower lateral incisor region.

In ten years in Sheffield 4 cases have presented, and Rose (1954) found 1 among 32 cases of extra teeth. The explanation may be that Stafne conducted his survey upon a mixed adult and juvenile population and that any extra lower incisor had already been extracted.

In the canine regions, the incidence of supplementary teeth is comparatively rare. Out of 48,550 persons, Stafne could only find 3 supplemental canine teeth, 2 being in the upper canine region and 1 in the lower. Fastlicht (1943) and de Jonge (1948) report symmetrical duplication of both upper permanent canines, and Oehlers (1950) reports the unilateral duplication of an upper deciduous canine. Over a period of ten years in Sheffield, we could only find 1 case with 3 unerupted upper supplemental canines and 1 other case with an erupted supplemental lower canine. Stafne, however, found a greater incidence in the upper and lower canine regions of diminutive teeth or denticles, occurring either in groups or singly, and also compound composite odontomes. He reports upon 50 such cases. Ottolengui (1931) and Ribble (1931) also report on similar cases. Two cases have presented in the Sheffield orthodontic department.

Extra teeth in the premolar region occur more commonly in the mandible, where they are almost always supplemental premolars. In the upper premolar regions a conical supernumerary tooth sometimes occurs. The majority of reports in the dental literature upon extra teeth in premolar regions concern patients from the East or from Africa. Still (1945) reports several cases and states that in Southern Nigeria approximately one person in every hundred has one or more extra premolar teeth.

Small conical supernumerary teeth occurring mesiobuccally to the upper third molar and sometimes the upper second molar were first described and named paramolars by Bolk (1914). They are sometimes fused to these upper molars.

Fourth molars or distomolars, as Bolk called them, can either be conical or resemble small molars. They occur either directly distal or distolingual to the upper third molar. Hendler (1935) reports 4 cases and explains that these would be observed more frequently, but for this area lying beyond the limit of the ordinary upper molar radiograph.

In addition to the situations already mentioned, supernumerary teeth sometimes occur in more remote areas. Goldman (1949) reports a patient having a supernumerary tooth upon the anterior wall of the right maxillary sinus. Fastlicht (1943) shows a

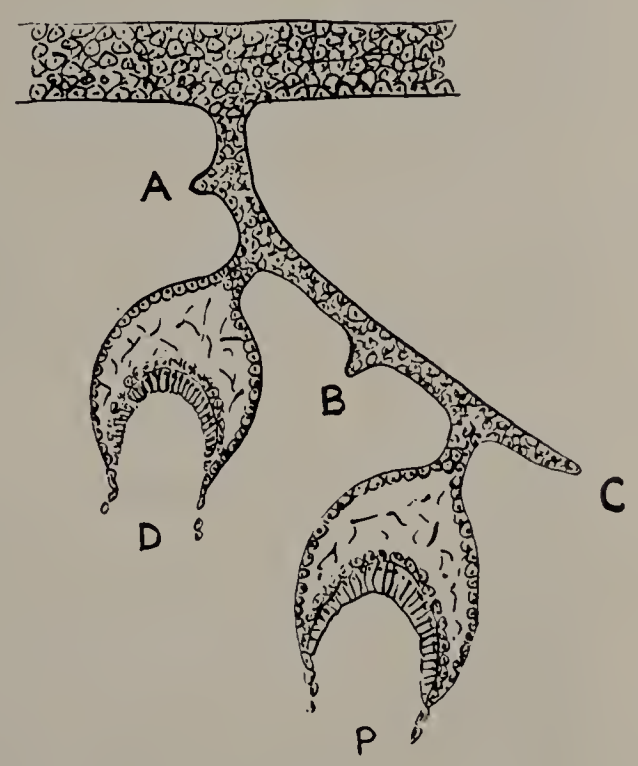


Fig. 1.—A developing tooth-band showing the situation of: deciduous tooth germ (D); permanent tooth germ (P); site of pre-deciduous type of supernumerary tooth (A); site of more common type of supernumerary (B); and site of post-permanent type of supernumerary (C). (*After E. Sprawson.*)

conical tooth in the floor of the nasal cavity in a pre-Columbian Indian skull, and Thomas Bell (1829) writes of "a cuspidatus, or a supernumerary tooth resembling it . . . projecting into the right nostril, to the extent of three quarters of an inch".

De Lapersonne and Monier (1924) report upon a girl of 15 years who had twelve or more small supernumerary teeth protruding through the sphenomaxillary fissure into the orbit.

AETIOLOGY

Various theorics have been advanced to explain the origin of these extra teeth: (1) Atavism; (2) Excessive growth of thc dental lamina; (3) Proliferation of remnants of the

dental lamina; (4) Dichotomy of the tooth germ; (5) Heredity; (6) General conditions.

1. The theory of atavism (the recurrence of the ancestral forms of teeth which have become extinct) is not now held so strongly, as, in the case of supplemental canines for instance, it has been shown that there never have been more than four canines in the mammalian dentition.

2. A more favoured theory is that of excessive growth in the epithelial tooth-band or dental lamina (*Fig.* 1) as put forward by Black (1909). Abnormal proliferations could arise at point A giving rise to the pre-deciduous type of supernumerary "tooth", sometimes seen upon the mandibular gum pads of the newborn child in the incisor region as horny structures which are usually shed after the first few weeks of life.

The more common type of supernumerary tooth could arise at point B. If situated too close to the regular tooth germ it may become fused to it. The post-permanent type of supernumerary tooth could arise at point C. Evidence of the development of post-permanent supernumerary teeth is provided by

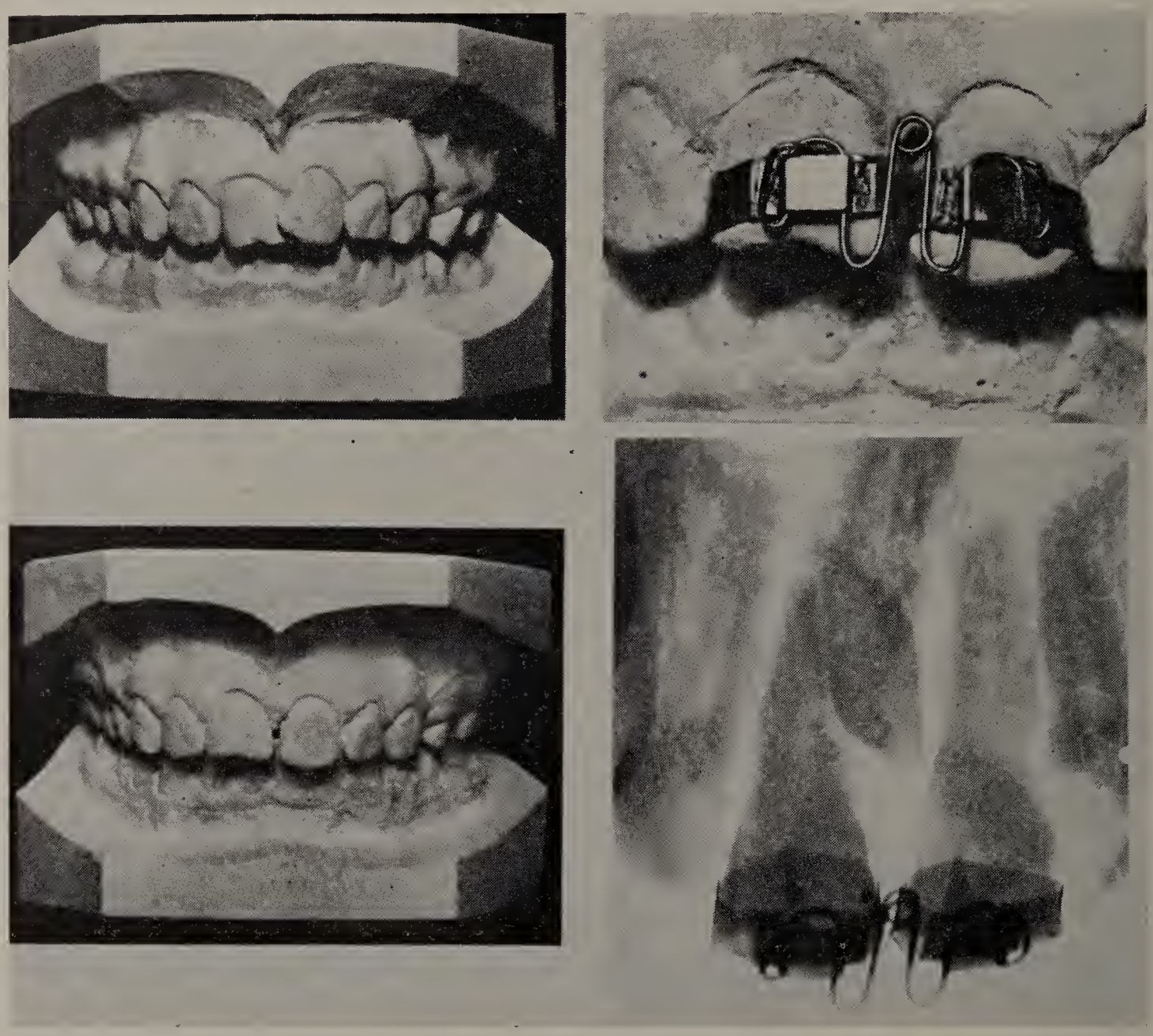


Fig. 2.—Relapse in treatment due to unobserved unerupted supernumerary tooth.

Marré (1940), Adelstein (1943), Oehlers (1952), and Cowan (1952), who show partially developed extra premolars *after* the regular premolars have completed their root formation.

3. Black also stated that groups of epithelial cells left after the breaking-up of the epithelial cords could, as a result of unknown stimulating conditions, develop into the tooth germ of a future supernumerary tooth. Zukerkandl (1929) reported that about 3 per cent of crania examined by him were found to

contain enamel-less tooth rudiments in the incisor regions.

4. Yet another theory is that a tooth germ may undergo dichotomy. If the division is equal, the result is a supplemental tooth resembling the normal series, but, if unequal, the additional tooth might be malformed and conical.

5. Heredity has been put forward as another explanation of supernumerary teeth. Stafne (1931), in his very complete survey on the subject, states: "A sufficient number of persons gave histories of the same abnormality having been seen in other members of their families to corroborate the belief that it has a hereditary tendency to occur. . . . The form and position of the teeth of various relatives were almost identically the same." Flint (1939) and Payne (1930) also found that case-histories show heredity to play a part. Similar conditions were found in a sister and a brother aged 9 and 10 years respectively and in two brothers aged 10 and 12 years.

6. General conditions: It is generally admitted that some general diseases can affect the tooth germ and a higher proportion of supernumerary teeth are found in such conditions as cleido-cranial dysostosis (Payne, 1930; Chipps, 1951; Brash, 1956) and cleft palate (Millhon and Stafne, 1941).

DIAGNOSIS

Undoubtedly the prime requisite in the diagnosis of unerupted extra teeth is a good radiographic examination, as is shown by the case illustrated in *Fig.* 2. The patient presented with a slight overlapping of the upper central incisors. After treatment and retention the case relapsed twice. Radiographic examination showed a small supernumerary tooth to be lying across the apex of one of the incisors. After the removal of this extra tooth, treatment was then completed uneventfully.

Bartleman (1932) also emphasizes the need for complete radiographic examination in these cases and describes a case referred to him for the removal of two erupted supernumerary teeth in the upper incisor region, which turned out to have, in addition, six unerupted lower supplementary premolars and four unerupted upper premolars.

Hendler (1935) states that extra teeth in the molar region often lie beyond the area of the ordinary small radiograph. An occlusal view or even a stereoscopic technique (Strickland, 1945; Tulley and Campbell, 1960) helps to localize the position of these extra teeth. Possibly the most accurate information is derived from a vertex occlusal view as described by Hitchin (1956) (*Fig.* 3), for in this view the X-rays pass along the long axes of the teeth and any extra body is shown either lingual or buccal to the arch.

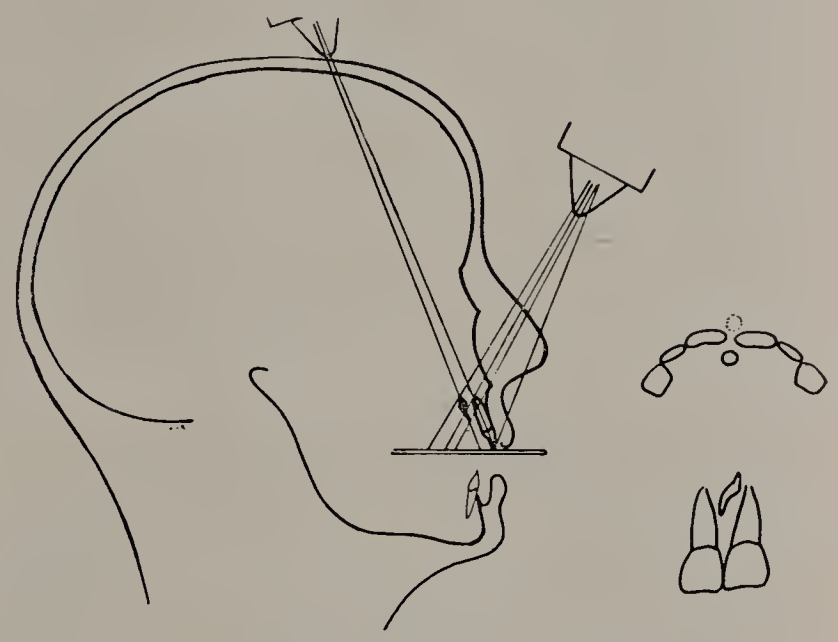


Fig. 3.—Diagram of a vertex occlusal and usual occlusal X-ray views. (*By kind permission of G. H. Roberts.*)

SEQUELÆ AND THEIR TREATMENT

Supernumerary and supplemental teeth are not invariably accompanied by malocclusion. In at least 7 per cent of the supernumerary tooth patients in Sheffield there was no associated irregularity, but the anomalies commonly associated with these extra teeth are: (1) Bodily displacement of teeth of the normal series—42 per cent; (2) Delayed eruption of associated permanent teeth—28 per cent; (3) Rotation of the normal teeth—21 per cent; (4) Gemination or fusion—3 per cent.

BODILY DISPLACEMENT

There is no clearly marked division between these conditions, since all could occur in one patient, but certainly bodily displacement

was the most frequent, for it occurred in 42 of the 100 non-cleft palate supernumerary tooth patients presenting for orthodontic treatment in Sheffield. It was, as the name implies, a complete displacement of both crown and root to the same extent. The only a portion of the root being present. In all it took $7\frac{1}{2}$ months to move $\underline{1|}$ bodily through 7 mm., whereas in this 17-year-old patient (*Fig.* 5) it took 5 months to move the $\underline{1|}$ through 3 mm. and the final adjustment and retention took a further 3 years.

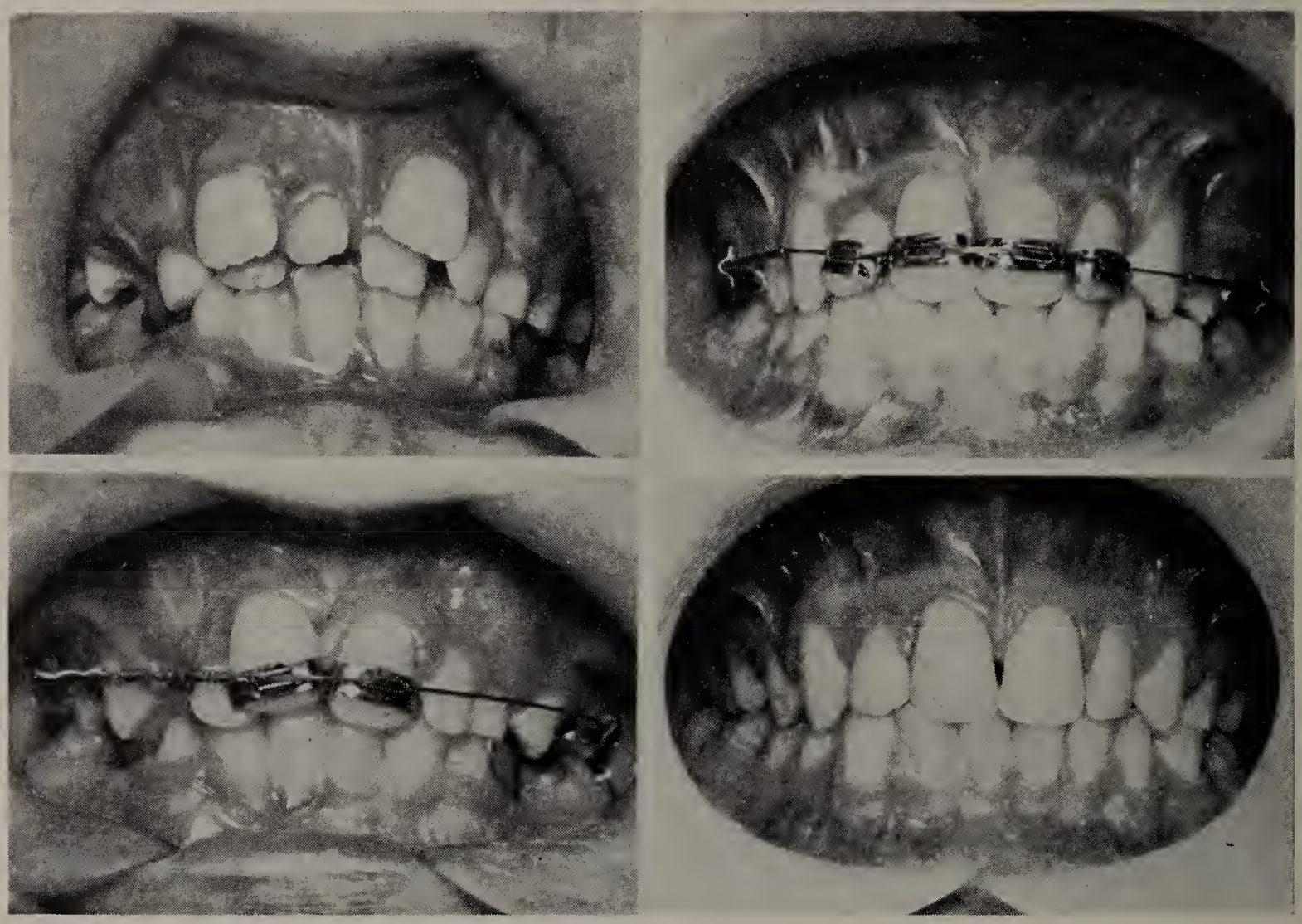


Fig. 4.—Stages in treating the displacement produced by two supplemental lateral incisors between $\underline{1|1}$ in a patient of 8 years.

explanation of this displacement may be that the forming crown of the normal permanent tooth was displaced from its normal path of development by the supernumerary teeth growing alongside it on the tooth-band or dental lamina.

John Hunter stated in 1771, "When there are supernumerary teeth, it will, in general, be proper to have them drawn". But in addition to extraction of extra teeth, there is the alinement of the displaced neighbouring teeth. In most cases this was achieved with helical springs upon a round or edgewise arch, as in this patient of 8 years (*Fig.* 4), thus having a reciprocal action in moving the displaced incisors mesially and the molars distally. In the case of this young patient, root movement was probably facilitated by

In a labiolingual direction, the normal incisors appear to be more often displaced labially by supernumerary teeth, and so when the latter have been extracted the incisors can be alined by the use of removable appliances.

DELAYED ERUPTION

Twenty-eight per cent of the supernumerary tooth cases in Sheffield were accompanied by delayed eruption of the upper permanent incisors and it was undoubtedly their appearance that prompted the parents to take action. Before attending the Dental Hospital, more than one of these patients had already been provided with a partial denture in the belief that the upper incisors were absent!

The first obvious point in treatment, following radiographic examination, is usually to extract the unerupted supernumeraries, though Stoy (1954) published some interesting findings. He showed by true vertex occlusal views that there may be no actual contact between the hard tissues of the unerupted supernumerary teeth and the unerupted central incisors, and that extraction of the supernumerary teeth alone does not necessarily result in the eruption of these incisors. If, however, the tissue overlying the incisal edges of the unerupted incisors is removed then, even though the supernumeraries are left in place, the incisors erupt. It would seem, therefore, that in addition to removing the supernumerary teeth it is also advisable to uncover the incisal edges of the unerupted incisors.

Following this, the next most important point is the provision of sufficient space, mesiodistally, in the dental arch. The incisors, following surgical exposure, usually erupt on their own, sometimes into surprisingly good alinement. So often, though, in these cases the erupted lateral incisors have drifted mesially and there is insufficient room for the central incisors. This can be provided with a simple finger-spring plate or a Badcock-type of screw plate, as described by Dickson (1959), and, in some cases, $\underline{4|4}$ may have to be extracted to facilitate the distal movement of the upper canines and lateral incisors. Where removable appliances are not advisable, a simple local fixed appliance can be used.

Upon full eruption, the incisors may not require alining, but if required, this can be accomplished with an apron-spring plate, the usual twin-arch (*Fig.* 6), or a single round-wire arch.

Occasionally one of the unerupted incisors is very much displaced or impacted and requires special consideration. In one such case, a spring operated by the patient upon a denture was used. When this right central had been moved sufficiently labially it was possible to use a facial arch disguised by a denture until a band could be made around it for traction in the ordinary way.

In another case, having made space in the arch with a local pin and tube appliance (*Fig.* 7), this latter was extended into the labial sulcus to retain a zinc-oxide/eugenol/cotton-wool pack and the tooth eventually banded and included in a round-wire arch.

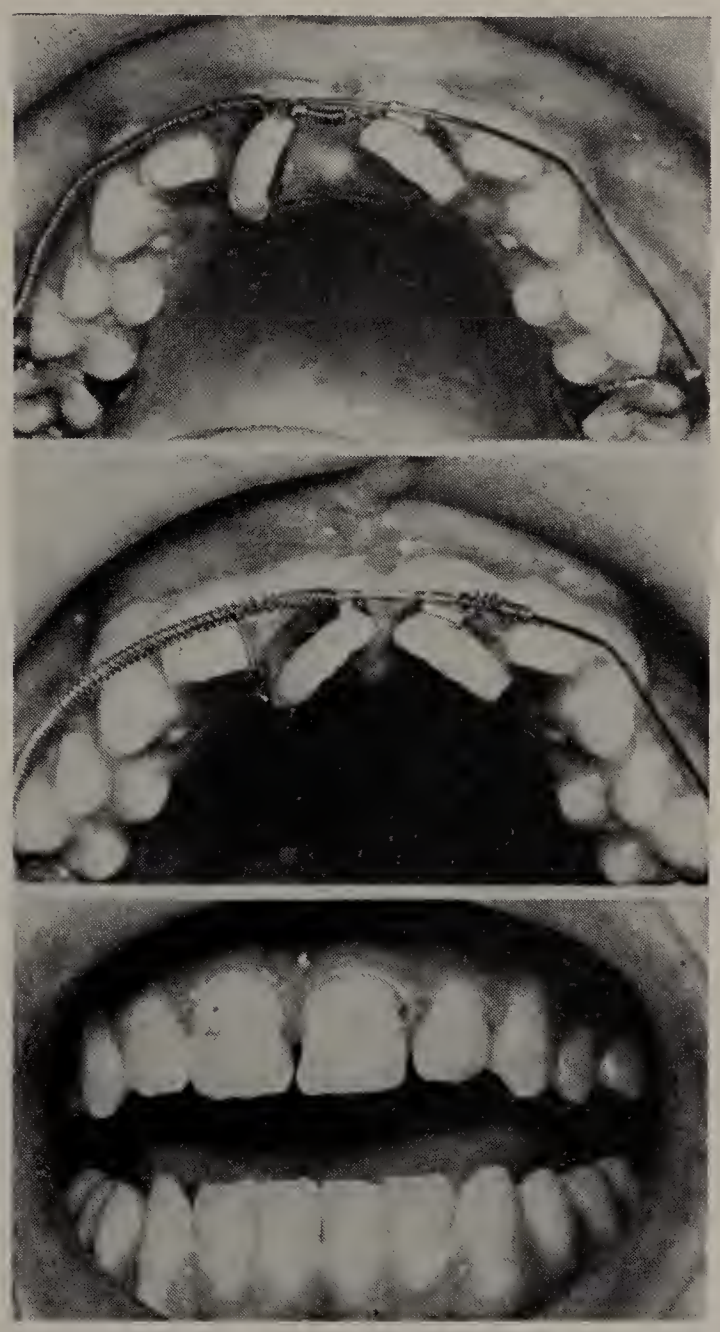


Fig. 5.—Stages in treating the displacement produced by two midline supernumerary teeth in a patient of 17 years.

More recently in a 9-year-old girl with a horizontal displacement of an upper central incisor a band was pre-formed upon the erupted central, then when the unerupted central had been uncovered surgically, it was cemented in place and a ligature carried through the flap to this multi-purpose 0·6 mm. round facial arch (*Fig.* 8). This arch served not only to widen the space but also to draw the unerupted central both occlusally and lingually until more orthodox arches could be employed.

ROTATIONS

In 21 of the 100 cases under consideration, the presence of supernumerary teeth was associated with rotation of the central incisors. These were treated almost entirely with fixed appliances such as the twin-wire and 0·45-mm. single round-wire arches. Whether Sheffield children are more boisterous with their appliances or not, I cannot say, but a high proportion presented with fracture of the wire staple attachment (*Fig.* 9 A) used when ligaturing a rotated tooth to a wire arch. A perforated tab made from 3·0 × 0·2 mm. soft tape was therefore developed (*Fig.* 9 B). The hole was drilled with a No. 1 carbide-tipped rose-head bur or the embossing produced by a rubber dam punch was stoned down. These were found to stand up to even the most boisterous patient.

One other problem which may be peculiar to Sheffield is the disinclination of girls above 13 years of age to have "any wire that shows in the front". One answer we have found in such cases where an anterior tooth is rotated is to carry a ligature from the band to an activated finger spring upon a lingual bow (*Fig.* 10).

The idea of the "whip" is, of course, well known, and usually consists of a short arm from a bracket on a band with its free end formed into a hook and latched over the facial arch which can be fixed or removable. Where a welder is not available, it is possible to utilize a cast silver cap upon the rotated tooth with the doubled wire pulled into a short tube cast with the cap (*Fig.* 11).

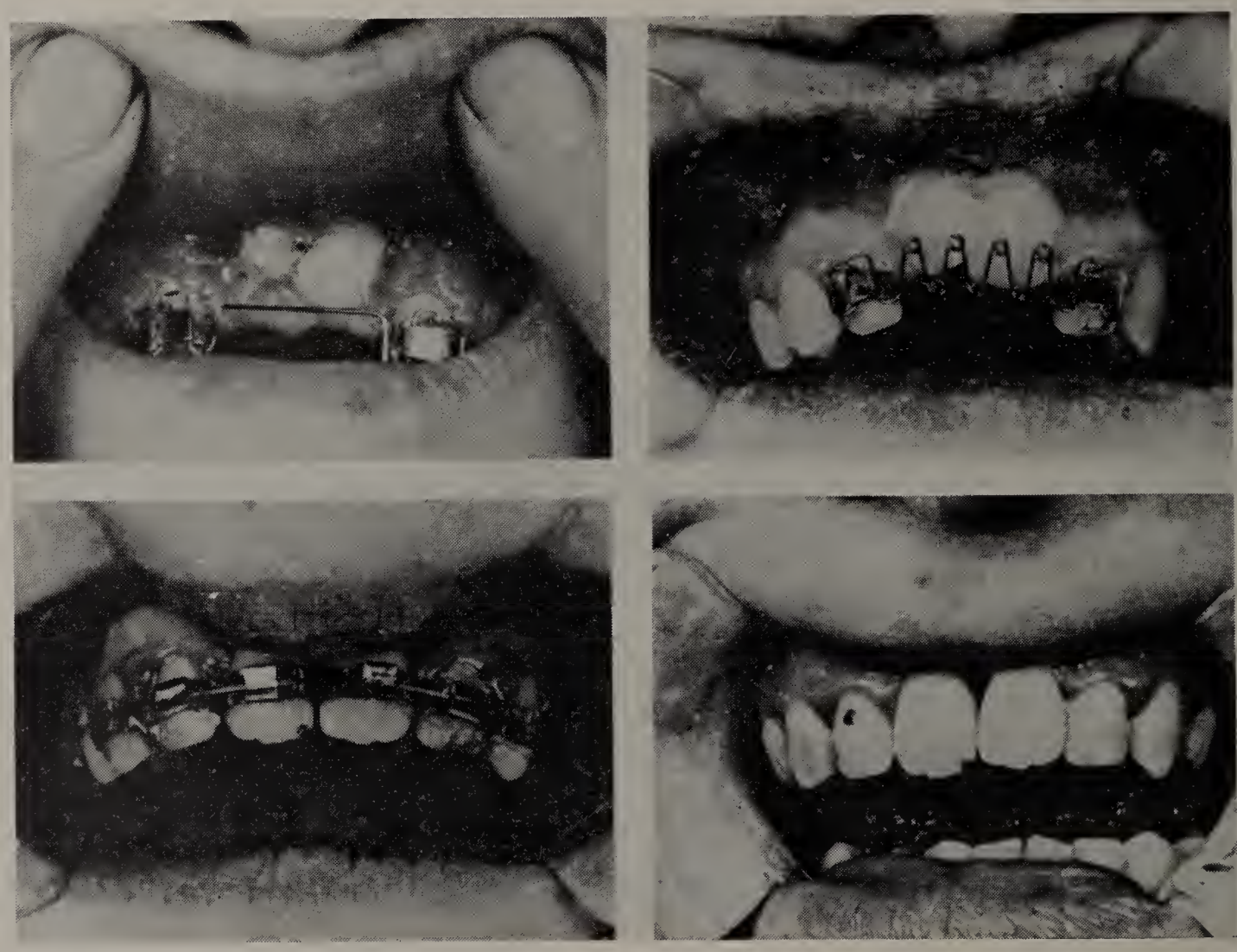


Fig. 6.—Stages in treating a patient of 14 years, the eruption of whose $\underline{1|1}$ had been delayed by supernumerary teeth.

Having corrected these rotated teeth, their retention proved to be lengthy. Reitan (1958) showed that there was tension in certain fibres of the periodontal membrane even $7\frac{1}{2}$ months after active rotation of the tooth had ceased. Clinically, we found it advisable, despite the protests of the patient, to leave the twin or other wire arch in position for at least 4 months after the tooth was corrected before considering a Hawley retainer or the spur type of retainer for a further 4 months; our decision depending upon our assessment of the likelihood of

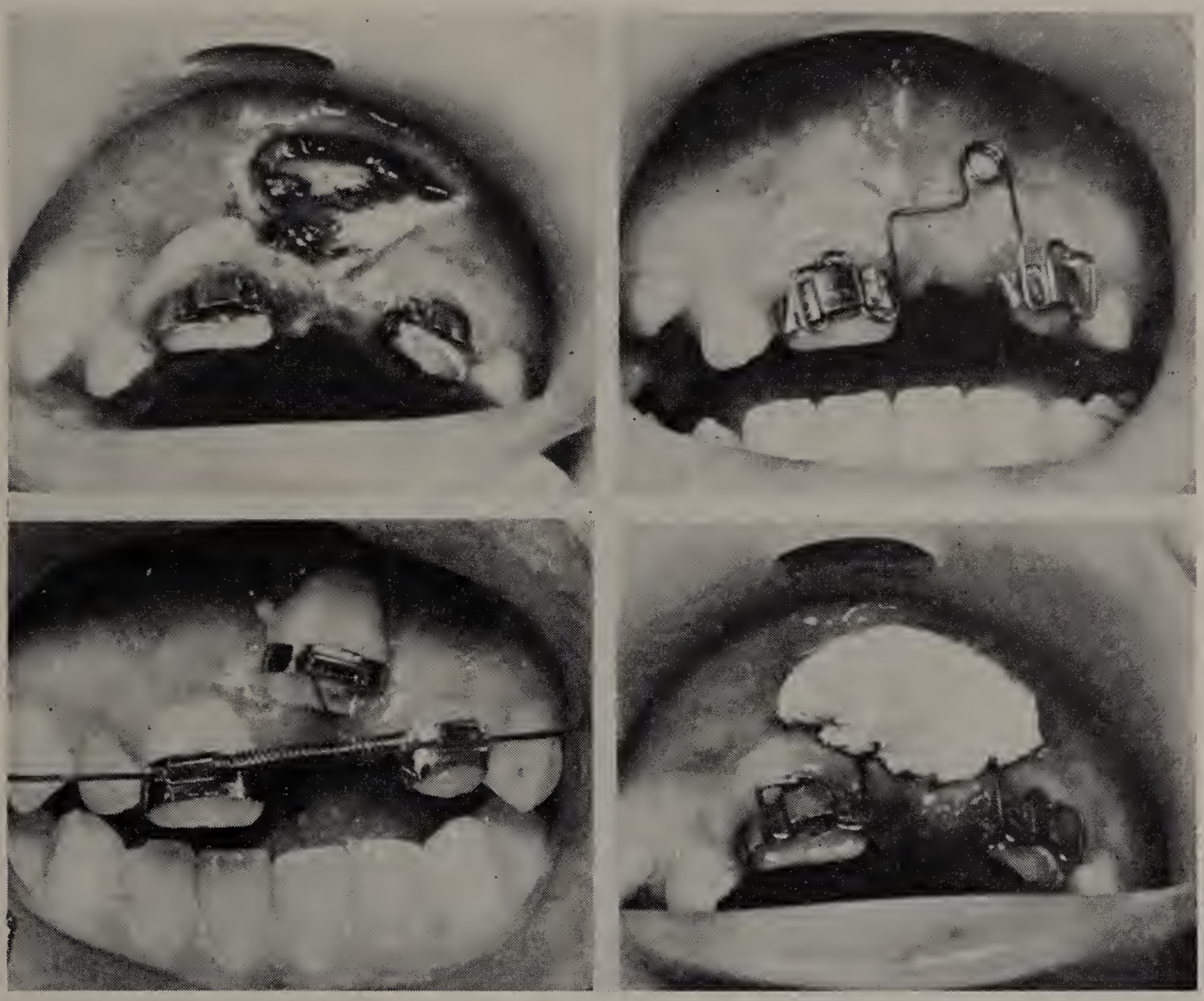


Fig. 7.—Creating a space for an unerupted central incisor whilst holding a zinc-oxide–clove-oil–cotton-wool pack in the sulcus.

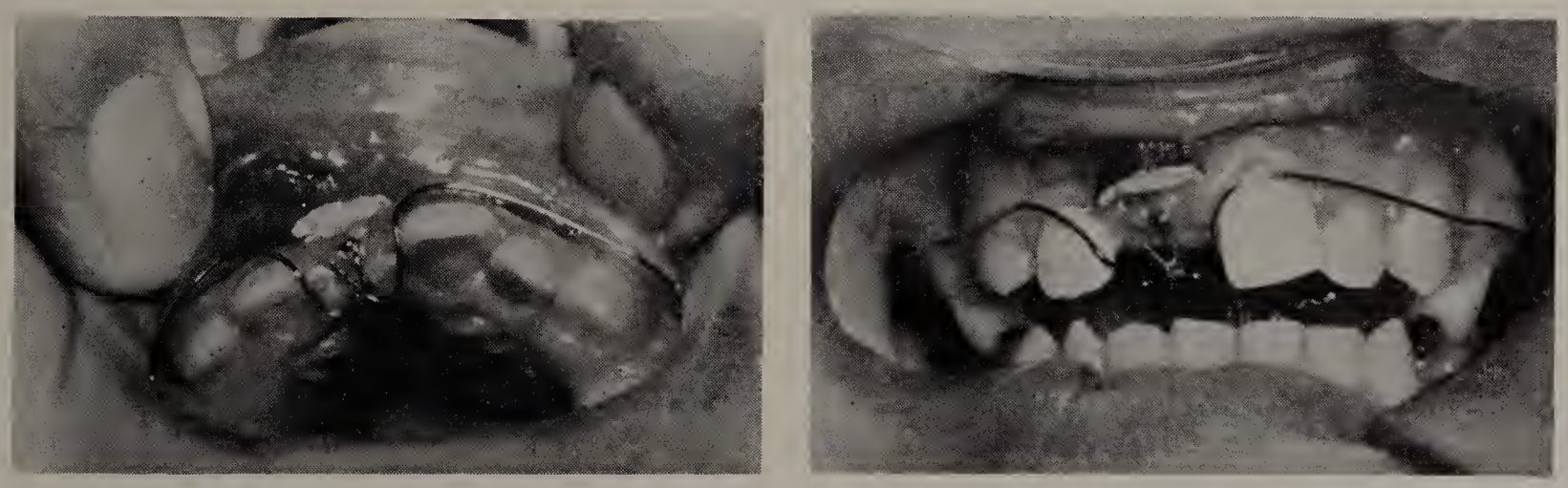


Fig. 8.—A multi-purpose round-wire arch (0·6-mm. diameter wire) for moving an unerupted upper incisor occlusally and lingually whilst creating a space for it anteriorly.

continuous contact between the removable appliance and the patient!

GEMINATION OR FUSION

The gemination or fusion of teeth was described by Blake as early as 1801, and in this present series in Sheffield was found to occur in 3 permanent teeth out of the 100 patients with extra teeth. Tinn (1940) reports a similar number in the permanent teeth of 8500 schoolchildren, but found 22 instances of fused teeth in the deciduous dentition. Others have made similar findings, e.g., Munro (1958) reports upon 31 cases of gemination in the deciduous dentition, 17 of these occurring in the maxillary incisor region and 14 in the mandibular incisor-canine region. He also reports that of the permanent successors to these geminated teeth, 12 were missing, 9 appeared normal, 6 were of

abnormal form, and 4 were associated with extra teeth.

Various explanations are put forward to account for this condition of gemination. Following Black's theory, it is conceivable that if an extra tooth forms on the dental lamina too close to the normal tooth, then it come into contact. If this occurs in the very early stages, there will be complete

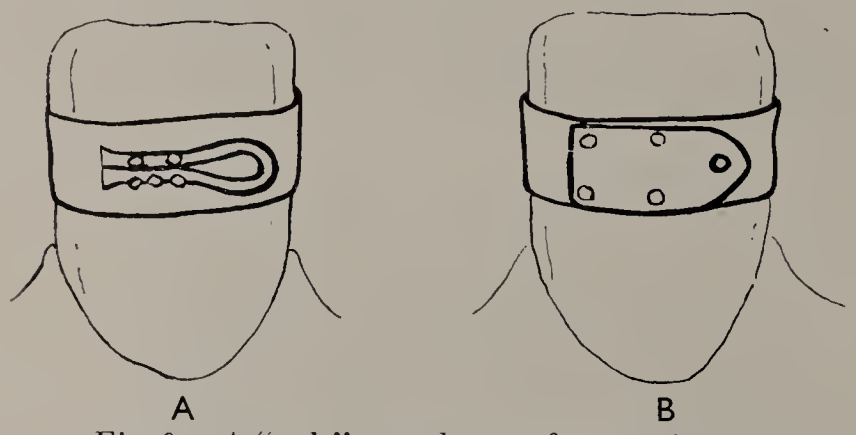


Fig. 9.—A "tab" attachment for rotating an incisor.

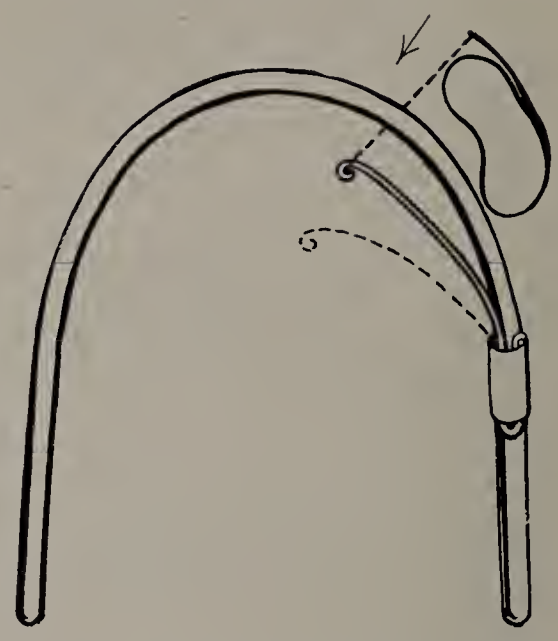


Fig. 10.—A short lingual finger spring and ligature for rotating an incisor.

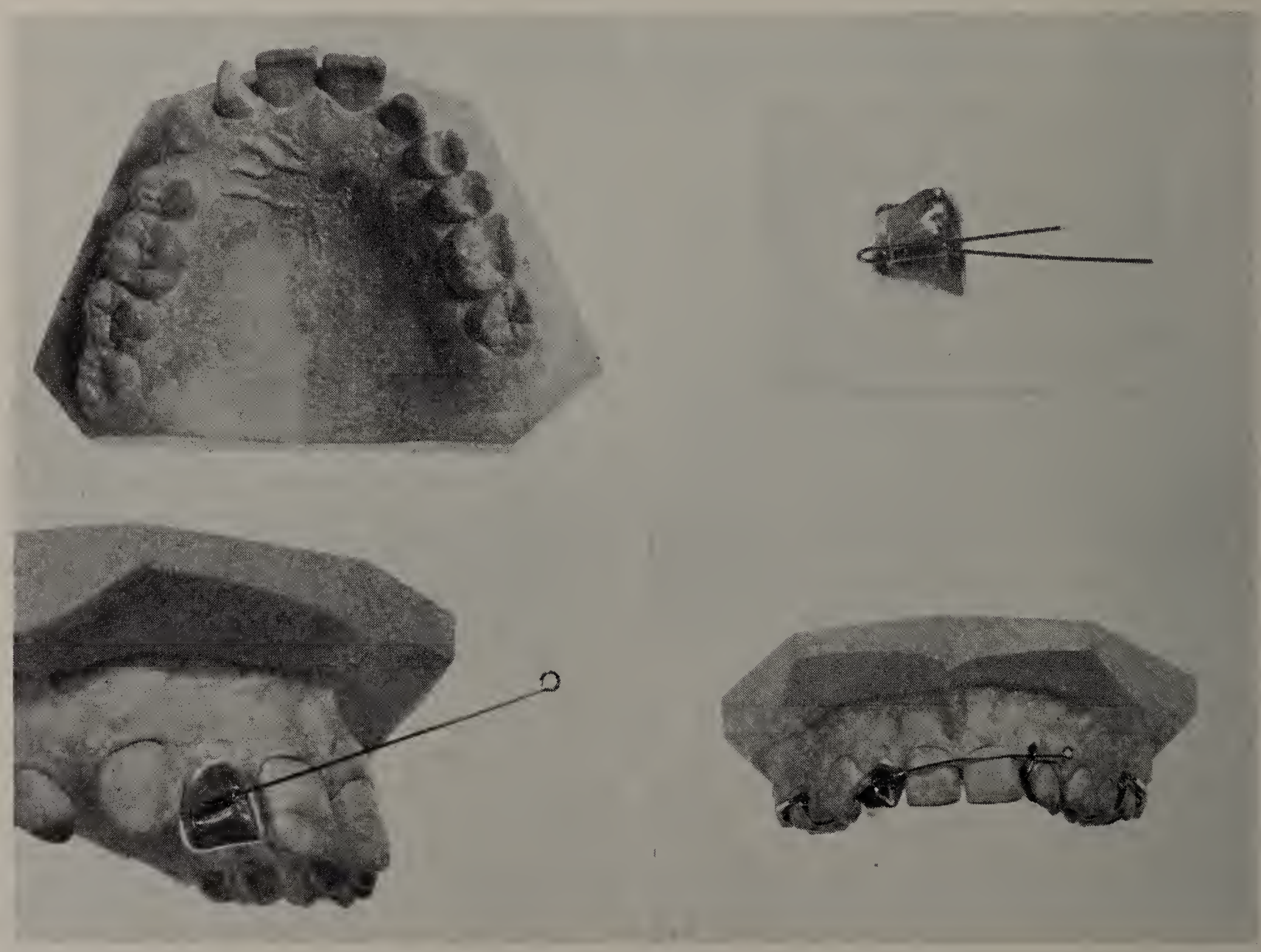


Fig. 11.—A cast silver cap and "whip" for rotating an incisor.

may become attached to it, and the degree of union will depend upon the stage of tooth formation reached when the two tooth germs fusion, but if the crowns have become partially formed then a clear line of separation exists.

Most geminations occur either mesially or distally, producing a displacement of the neighbouring teeth. Where, however, an extra cusp occurs lingually it can cause a malocclusion in the opposing jaw. As a part of the treatment in such a case, we were proposing gradually to grind away this offending cusp and root-fill its canal if necessary, but the patient saved us the trouble by failing to turn up for her appointments!

Other forms of gemination are so complete that it is difficult to see any demarcation. Even this very wide central incisor had a common pulp with its adjoining supplementary tooth. The treatment in this case was to extract this wide central, approximate the neighbouring teeth by means of helical springs upon a twin-wire arch, then finally to add a jacket crown to the $\underline{|2}$. I recently saw this patient five years after completion of treatment and he seemed quite satisfied.

I have heard that with these giant-sized central incisors it is possible to disk a groove labially and incisally, darken this with silver nitrate, then add a triangular pink acrylic inlay at gingival level.

Acknowledgements.—I would like to acknowledge, with gratitude, the help I have received from Miss J. M. Kershaw of the Lindsey Library for tracing many of the references given in this paper, and for the loan of several of the lantern slides I would like to thank Professor Roberts. My thanks are also due to Mrs. Walkland for preparing *Fig.* 10, and to Mr. Cousins, of the Sheffield Dental Hospital Photographic Department, for all the photographs and lantern slide preparations.

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DISCUSSION

Mr. W. J. Tulley said that Mr. Gardiner had not really left very much for him to say. He would disagree on one or two small points. Mr. Gardiner had said that supernumeraries were commonplace. How many general practitioners saw a supernumerary tooth in a year? He did not think that they were commonplace in relation to the rest of malocclusions.

Mr. Gardiner had discussed the literature thoroughly, and it was always a great thing to listen to the words of John Hunter and Joseph Fox; there had not been a lot new since their day.

He thought that there were probably quite a lot more supernumeraries in the deciduous dentition which got by without necessarily being seen—certainly without being reported. In the surgical removal of supernumeraries, one should not be too premature. One should not remove them just because they happened to be seen on an X-ray in a child of 6 or 7, before the permanent incisors had had a chance to erupt. There was always the danger of taking out or damaging something other than the supernumerary.

With regard to occlusal traction along the long axis of those teeth, he thought that, where it was possible, it was far better to let them erupt on their own. He had seen teeth die by rather excessive occlusal traction applied to them.

He was intrigued with the method of masking a large geminated incisor.

Mr. Gardiner had shown one case where a supernumerary seemed to be a good thing. There was a carious molar and a supernumerary molar just waiting to erupt in its place. He wondered how often one could make use of those supernumeraries to replace other teeth.

Mr. H. L. Leech asked if Mr. Gardiner included cleft-palate cases in the series of supernumerary teeth.

Mr. E. S. Broadway showed three slides and asked for Mr. Gardiner's comments.

The first slide showed a case which had recently been sent to him of a supernumerary in the upper anterior region, in July. The next slide showed the picture in October, the supernumerary having been removed 2 months previously. The third slide showed that it had come back again.

The supernumerary had, in fact, been removed by a very able general practitioner. He had dissected the tooth out most carefully, and had been a little disappointed that the upper central incisor had not, in fact, erupted as he thought it should have done. He had taken a new X-ray in January, 6 months after the original supernumerary was removed, and discovered that, in fact, the thing had recurred.

Professor Poynton had described a case in an American journal where premolars had recurred following the removal of supernumerary premolars.

Had anyone else seen similar cases, and could Mr. Gardiner, or anyone else, offer an explanation of that rather unusual condition?

Mr. J. C. Richie said there were two points he wanted to mention. First of all, with regard to the geminated teeth and the geminated pulp on the lingual aspect of the upper incisor teeth, it had been his experience to grind those down where they interfered with the bite and to treat the exposed dentine, or near exposure, with phenol.

His other point was the fact that he seemed to get a number of patients sent to him these days where an impacted central tooth had been removed either by the general dental surgeon or the oral surgeon and the patient sent to him to resolve the orthodontic problem. He would like to go into print as advising those practitioners against removing single teeth in that way, because he felt that the dental "cyclops" was probably the most difficult type of orthodontic case to treat.

Mr. A. G. Huddart thanked Mr. Gardiner for a very interesting paper.

On the question of cleft palates, Mr. Gardiner had commented that 43 per cent had supernumerary teeth present. His own feelings were that a lot of these cases showed absence of the lateral incisors in the line of the cleft and the presence of a rudimentary, peg-shaped tooth instead, i.e., a supernumerary tooth so called. He would be grateful for Mr. Gardiner's comments on this.

On the question of midline diastemas, he had had one case of a boy with a diastema of about 9–10 mm. associated with two unerupted supernumerary teeth. These were removed and he was simply kept under observation. Over a period of $2\frac{1}{2}$ years the space progressively closed, with no apparent tipping of the teeth; they seemed to move bodily together. The boy now had overlapping upper central incisors which would have to be treated.

Finally, he asked if Mr. Gardiner felt these unerupted supernumerary teeth could possibly cause resorption of the roots of the permanent incisors.

Mr. B. C. Leighton added his congratulations to Mr. Gardiner on the paper. He had gained the impression, when Mr. Gardiner was speaking, that he considered that the position B in the diagram of the tooth germs was perhaps the one from which supernumeraries most commonly arose. Would one not expect, if they arose at that point, that they would develop more commonly on the labial side of the permanent incisors? He would have thought that they would arise from position C more commonly if they developed on the lingual side of the permanent incisors, as they seemed to most often.

With regard to Mr. Broadway's case, he himself had been taught, when removing all unerupted teeth, to curette away the tooth follicle. Was it possible that the dental surgeon who removed them did not curette the tooth follicle and left some of that behind?

Mr. A. J. Walpole Day thanked Mr. Gardiner for his wonderful paper. He had not left much for them to say, but Mr. Broadway, in his observations about the tooth that came back, had reminded him of a similar case of a boy of 14, who had an unerupted central and three tuberculated supernumeraries, one with the whole of the crown formed, one with half a crown formed, and one which was just beginning to form and was just like the thinnest little snowflake of a tooth. A lot of these tuberculated supernumeraries were very late in developing and formed a long time after the permanent teeth.

Mr. W. J. Tulley, referring to Mr. Broadway's comments on a tooth that reappeared, wondered if Mr. Gardiner had seen a supernumerary disappear. Cases had been known of foreign bodies in the floor of the nose showing up and looking very much like supernumerary teeth and, on operation, the endotracheal tube pushed them somewhere.

Mr. E. S. Broadway wanted to ask Mr. Gardiner if he took any precaution to protect patients from irradiation

when taking vertex occlusal films because they seemed to require a very high dosage, and the rays tended to cover the abdomen almost completely when those were taken.

Mr. Gardiner, in reply, thanked Mr. Tulley for opening the discussion so ably.

In reply to Mr. Leech, he said that the cleft-palate patients were extra. An altogether separate survey had been done on those and it was found that the incidence of supernumerary teeth was very much higher.

Mr. Huddart had mentioned pre-deciduous teeth. Could Mr. Huddart tell him the appearance of those? They had been described as shell-like, and Allwright said that the radicular portion had a very small opening, just like the apex of a normal root. Would Mr. Huddart say that they were similar?

Mr. Huddart said that the best way he could describe them was that they were just like a conical incisor lying on the surface of the gum.

Mr. Gardiner asked if they had any enamel formation.

Mr. Huddart said that he could not say.

With regard to Mr. Huddart's question about supernumeraries causing resorption of incisors, the supernumeraries in question just seemed to melt away; they did not seem to have the chance to cause resorption of the incisors.

In reply to Mr. Leighton's question about the position of the developing supernumerary tooth on the dental lamina, if it erupted subsequently to the permanent teeth, he would think that the extent of the root development would possibly show that.

He thanked Mr. Day for presenting so clearly his case of the boy with three supernumeraries in various stages of development.

In reply to Mr. E. S. Broadway, they had now started putting a protective apron over the children when they took the rather long X-ray exposures with a more powerful machine.

RESORPTION OF INCISORS DUE TO MALDIRECTION OF ERUPTION OF UPPER CANINES

By **E. S. BROADWAY**, B.D.S., F.D.S., D.Orth. R.C.S.

Resorption of incisors due to malposition of the upper canines is fortunately rare. In the majority of cases where the position of the canines is such as to make their eruption into the arch uncertain, if these teeth are left undisturbed they rarely give rise to any trouble.

When resorption of the incisors does occur it usually starts at an early stage and seems to be more common in the 8–14-year age-group than later on. This makes the early diagnosis of the condition difficult. One may not suspect that the canines are misplaced at this stage of the eruption of the dentition, and usually the first sign of resorption of the incisors is when the patient complains of pain in these teeth.

The speed at which resorption takes place is difficult to assess, as the condition is usually treated as soon as it is diagnosed, but there is no doubt that in some cases it is extremely rapid. Mr. Hovell, in a personal communication, reports a case of an 8-year-old patient where the roots of the lateral incisors were completely resorbed. That the condition is not always progressive is illustrated by *Fig.* 1. The malposition of the upper canines was first noticed on radiographs at the age of 9 years. Unfortunately these X-rays are not available, so it is not possible to say if any resorption of the incisors had occurred at this stage. The present position at the age of 27 years is that all the incisors are resorbed to half their length and this has apparently been static for some years. The incisors are vital and of good colour and quite firm.

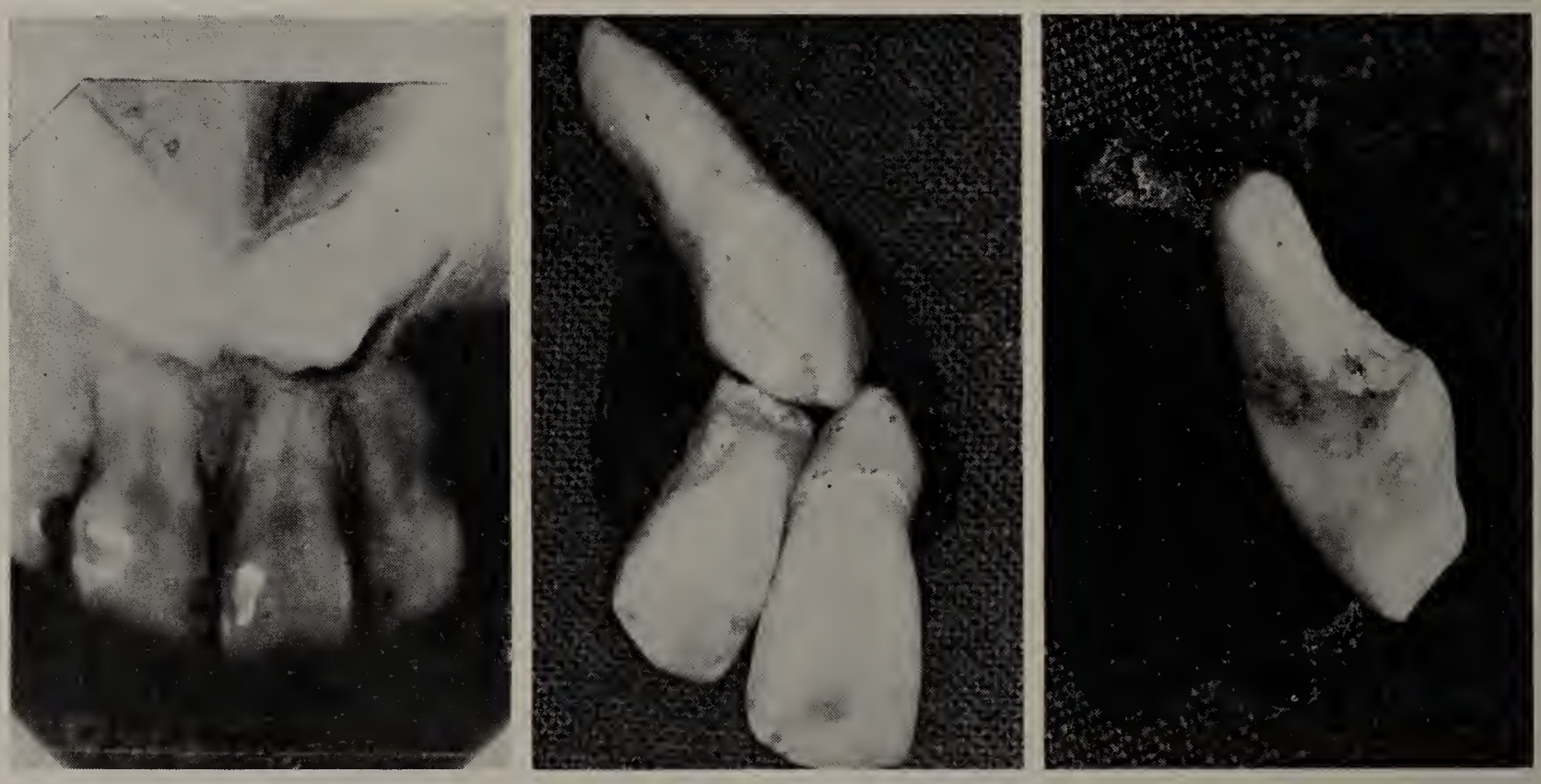

Fig. 1.—Case of resorption of the upper incisors by the upper canines.

It would seem that the main clinical feature of resorption of the incisors is pain, which only occurs at a somewhat late stage. Mobility of the affected teeth is not usually more marked, and one can be surprised by the extent of the resorption shown on radiographs when the

Given at the meeting held on February 13, 1961.

teeth are quite firm. Histology of the canine follicles does not show any significant difference between normal follicles and those from teeth which have caused resorption. Rarely the buccally-placed canine causes resorption of lateral incisors, and I am indebted to Mr. D. I. Smith for the details of one of his cases in which this occurred.

A CASE OF CONGENITAL FACIAL PALSY

By **E. S. BROADWAY**, B.D.S., F.D.S., D.Orth. R.C.S.

CONGENITAL facial palsy is a rare condition. Facial-nerve palsy in children is uncommon, though this was not so in the past due to the higher incidence of mastoiditis and to the accidental damage to the seventh nerve during mastoidectomy. The incidence of mastoiditis has been much diminished by the use of antibiotics in the treatment of otitis media. Seventh-nerve palsy, which is usually of a transient nature, occasionally follows a difficult forceps delivery when the forceps have not been correctly applied. This is the result of indirect pressure on the nerve, which is quite superficial in infancy.

Bell's palsy is the other common condition. This occurs usually in adults and its aetiology is not definitely known. It is alleged to follow sitting in a draught and has been thought to be due to a virus infection or herpes of the nerve, though the latest research work on this condition shows this to be rather doubtful. A spontaneous remission usually occurs in cases of Bell's palsy, but care has to be taken to prevent the stretching of the facial muscles. Physiotherapy and a support from a dental splint to the upper lip are usually employed. Sometimes decompression of the seventh nerve is carried out by opening up the stylomastoid canal.

Cerebral hæmorrhage or thrombosis are other causes of facial-nerve weakness.

The following case illustrates a true congenital facial-nerve palsy (*Fig.* 1).

CASE REPORT

There is no family history of any hereditary disease or congenital malformation. The patient is the second eldest son of a family of four boys and two girls. The mother had a normal pregnancy which was followed by a normal delivery and no forceps were used. The birth weight was 9½ lb. It was noticed soon after birth that the infant had a left-sided facial weakness. When seen he was found to be a fit boy with an obvious seventh-nerve palsy. Examination of the central nervous system showed no abnormalities apart from a complete seventh-nerve palsy together with an associated loss of the left corneal reflex. The seventh-nerve weakness was complete, and

Fig. 1.—Case of true congenital facial-nerve palsy.

there was flaccid paralysis of all the facial muscles, including the supra-trochlear group. Function was good, though there was some epiphora.

The patient was referred for an opinion on his occlusion, and there was found to be flattening of the arches on the left side and the upper lateral incisor was inside the bite. The flattening of the arch was due to the loss of function of the buccinator and orbicularis oris muscles on this side. Orthodontic treatment was confined to the alinement of the upper incisors. It is proposed to put in some fascia lata slings at a later date to hold up the corner of the mouth and support the lower eyelid.

DISCUSSION

[The two prceding papers were discussed jointly.]

The President said that the great tragedy, of course, was that early resorption of a tooth did not cause pain and, by the time it did, usually things had gone too far. Had Mr. Broadway ever followed up a case where a palatal caninc had caused partial resorption of a lateral apex where the canine had been remnoved successfully without removing the lateral, and wherc the tooth had remained vital and symptomless over a long period of time? He pcrsonally was watching such a case and would be interested if other members had anything to contribute on this subject.

Mr. J. D. Hooper said that hc was very interested in Mr. Broadway's paper. He was worried by the emphasis on the word "pain". He had seen about a dozen cases over the past years in which there had been resorption of teeth, but he had not yet heard a patient complain of pain. They had all been picked up on routine checks, so he did not want people to get the idea that one could spot the condition because of pain, because that was not the experience in the cases he had seen. In three cases the teeth were so badly resorbed that they had to be extracted. It was a question of at what degree of resorption pain might ensue.

Mr. D. F. Glass said he was particularly interested in the fact that Mr. Broadway considered that the lingual compression of the jaws on the palsied side of the face was due in some way to the palsy. Mr. Glass wondered whethcr this was the true cause. He had seen some cases in which the jaws were bowcd outwards on the defective side, presumably due to the paralysis of the muscles on that side with the accompanying lack of muscle pressure. With regard to unerupted canines which frequently resorbed the roots of lateral and central incisors, did he consider that if the canines met in the midline they would resorb each other?

Mr. W. Russell Logan thanked Mr. Broadway for the very interesting cases that he had shown. He was interested in the case of the palsy with the lack of tone in the left side of the face. He had seen one or two of those cases and had always been surprised at how little disturbance there was in the shape of the arches. It was becoming known that if there was pressure exerted by the soft tissues on the teeth there was more from the tongue side than from the buccal side; one would expect a bowing of the arch to that side, but, in the cases of congenital palsy, it was indeed surprising how regular the arch was, and how there was very little disturbance at all in spite of lack of pressure from the buccal tissues and labial tissues on one side of the mouth.

Mr. A. G. Huddart said, with regard to the palatally impacted canines, in severe cases where they could not be alined satisfactorily, by orthodontic mcans, he had been advocating their removal. The oral surgeons, however, were sometimes reluctant to do this. Hc wondered whether Mr. Broadway had any idea what proportion of badly palatally displaced canines, such as those he had shown meeting in the midline, was likely to cause resorption of the adjacent permanent incisor roots?

Mr. M. A. Kettle agreed with Mr. Hooper that pain symptoms wcre very rare in these cases, and usually, on removal of thc impactcd canine, symptoms, such as they were, disappcared.

He did not feel that the resorption should be considered a continuous process; if the offending canine was removed it might continue for a short time, but come to an end, allowing the tooth to be retained in the mouth. That brought him to the case in which they had seen three teeth, two incisors and a canine, after extraction—a very beautiful picture, but he felt that the clinical picture would have been prettier if the canine alone had been removed.

Mr. Broadway, replying, said that he would like to reply firstly on the case of congenital facial palsy. Like Mr. Glass, he assumed that if there was a facial palsy, there should be a bowing out of the arch on the affected side, and, there being lack of muscle tone, the tongue should push the teeth out, so he had taken a very great deal of care to make sure that he got the sides right, and that in fact there was a flattening on the affected side, and not a bowing on the affected side. He thought Mr. Tulley's explanation was the correct one, that the flaccidity of the muscles acted rather like an orthodontic appliance. The muscle just lay on the teeth and put the arch slightly out of muscle balance and pushed the teeth in. If one thought about it, one could persuade oneself—at least, he had persuaded himself—that that was so, when one dealt with facial palsies. The edentulous patient with Bell's palsy found it difficult to keep down the lower and keep up the upper. The side that fell down was not the side where the muscles were active but the side where the muscles were paralysed; it dropped down, was pushed up, and dropped down again. Possibly that was an explanation of the problem. It would perhaps be nice to collect a series of those cases, and Mr. Glass probably had a better opportunity than anyone of collecting this series, working as he did in a big plastic unit.

As regards canines, on the first question, of pain, he hoped he had emphasized that this was a late symptom. When pain was felt, it was too late to do anything except take the painful tooth out. He agreed with Mr. Hooper that, if one had routine checks, one might find those cases before pain started and then do something about it. He was not sure what one could do about it, though, because when the canine was causing resorption of the incisors, one needed skilful oral surgery to remove the canine without damaging the roots of thc lateral or central incisors.

On Mr. Smith's question as to whether the crowns of the teeth had to be in contact, he did not know. All he could say was that in the two cases where the teeth were, in fact, removed, at Ipswich, the surgeon (Ireland) assured him that the teeth were in contact, but he himself saw no reason why they should be. He imagined pressure from the crypt could cause resorption of the root, though he did not know. That was the real answer—he did not know.

In reply to Mr. Kettle, he said that even if the canines were not removed, the resorption might stop. The last case illustrated that the tooth did not appear to be resorbing in the adult although considerable resorption had taken place at some time, presumably during the normal time of eruption of the canine. All the teeth which had been removed in that series had bccn removed by the oral surgeon because of acutc pain. None of them had becn removed just because they werc loose or because they seemed to be resorbed. The lateral incisor was removed for orthodontic reasons because it was felt that there was a better chance of getting a sound canine into place than leaving a resorbed lateral in place.

He hoped that he had covered the main points in the questions.

ANCHORAGE CONTROL IN SPACE CLOSURE

By **G. G. T. FLETCHER**, L.D.S., D.Orth. R.C.S.
Eastman Dental Hospital

It is the purpose of this paper to uncover the mechanical principles that are fundamental to accurate control of space closure, and to show where such control is needed.

Complete space closure may be, on occasions, a necessity, whilst at other times it need be no more than an incidental objective. Nevertheless, the systems of anchorage control to be outlined herein are the same, and still of importance, whether or not complete space closure is ultimately intended.

The problems that arise are dependent upon the amount and type of tooth movement to be carried out mechanically and the resultant reciprocal effect upon available anchorage. In practice, these problems will range from simple to complex, according to the relative difficulty of anchorage control in any given circumstance.

In gradually building up understanding of the implication of the above paragraph, an effort will be made not to obliterate basic reasoning and objectives beneath a welter of technical detail. Design of individual appliances may be important in the long run, but is secondary to fundamental principles.

The treatment of overcrowding in Angle's Class I cases provides a suitable introduction to the problems of anchorage control. In this type of case space must be gained to accommodate the malalined teeth. If, as is likely, the choice of expansion laterally or anteroposteriorly is debarred by an inadequacy of bone base and the influence of surrounding musculature, space must be obtained by extraction. Sufficient whole units must be removed so that the remainder can be moved into alinement without seriously altering the original mean arch dimensions. The choice of which units should be extracted, how many, and from what parts of the dental arches, is theoretically unrestricted. In finalizing his selection, the orthodontist will be guided by certain general considerations:—

1. Maintenance of symmetry, balance, and appearance of the upper and lower front six teeth.
2. Promotion or maintenance of symmetry throughout the dental arches.
3. Promotion or maintenance of occlusal harmony.
4. Promotion of the simplest forms of tooth movement consequent upon extraction, i.e., reduce to a minimum the number of teeth to be moved, and avoid, as far as possible, need for apical or bodily movement.
5. Promotion, by suitable segmentation of the arches, of an anchorage balance which is in accord with the intended tooth movement and selected appliance method.

The sum of these considerations, when applied in practice, will lead to many and varied choice of extractions. It is fortunately not necessary to consider all these variations, since the quite common choice of the first premolars, in association with Class I overcrowding, provides a suitable introduction to the space closure problem, first, in its simple, and then complex form.

If first premolars are extracted in such a condition, one of three situations will be produced, namely, where the space created is (1) less than, (2) equal to, or (3) exceeds the space required for the alinement of the remaining teeth (*Fig.* 1).

For the sake of simplicity, only one dental arch has been represented in the diagrams, and the reader should assume that the opposite arch presents an identical problem, and that, at this stage, cases of normal dental base relationship are being considered. In *Fig.* 1 A, B, C, geometrical rather than anatomical figures have been used to represent the teeth, and thus to emphasize that the teeth

Given at the meeting held on March 13, 1961.

have been rearranged geometrically and no account has been taken of possible anchorage shift.

Anchorage behaviour must be superimposed on the purely geometrical calculation at alinement. So long as these tooth movements are of the simple tilting variety, little stress will be put on the anchorage. Little, if any, space need have been created beyond that strictly required for alincment. No appliance

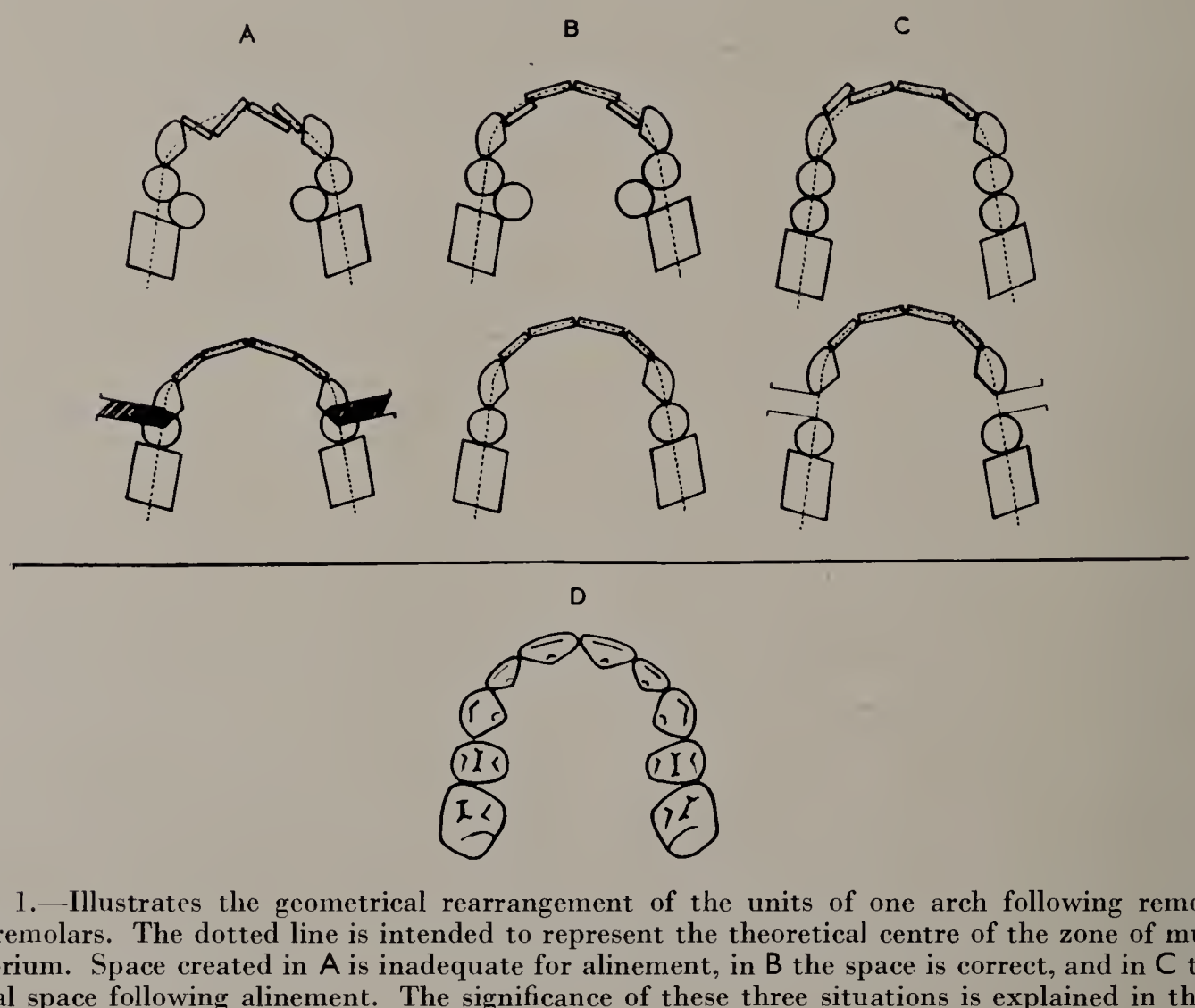

Fig. 1.—Illustrates the geometrical rearrangement of the units of one arch following removal of first premolars. The dotted line is intended to represent the theoretical centre of the zone of muscular equilibrium. Space created in A is inadequate for alinement, in B the space is correct, and in C there is residual space following alinement. The significance of these three situations is explained in the text.

the pre-treatment planning stage. All natural factors pertaining to anchorage, together with expected reactions of various appliance methods, must be mentally prejudged in relation to all possible extraction choices with a view to obtaining the result shown in *Fig.* 1 D. Such an ideal result may come about in practice through treatment planning and subsequent mechanics that are easy or difficult, the decisive factor being the nature of the original condition.

If only for later comparison's sake, a glance at space closure in its simplest form is justified (*Fig.* 2).

The mechanical problem in this case is one of preservation of anchorage stability. Neither the anterior nor posterior segments can be allowed to encroach on the space created whilst the intervening teeth are moved into need be used beyond a removable or labio-lingual type which possesses a rigid "body" of acrylic or stout archwire, and facility through auxiliary springs to tilt the teeth into position. Space closure in this instance is automatic, following general alinement.

Once simple tilting is replaced by the need for apical repositioning or bodily movement, strain on anchorage is increased. Potential resultant shift of anchorage must therefore be either allowed for or prevented.

To make allowance necessitates the provision of additional compensatory space over and above that required for alinement.

Prevention means the introduction of a stabilizing counterbalance by use of extra-oral traction and often the reduction in quantity of simultaneous tooth movement in any one direction. These latter measures, even if

eventually successful, are cumbersome, and reduce treatment progress to a crawl.

It is desirable, even with simple rigid appliances, to create enough space to allow for the full action and reaction to take place concurrently. In such circumstances these appliances can work fully reciprocally to the limit of their several capacities.

So long as space created is ideal in quantity and so located as to harmonize with the actions and reactions of chosen appliances (i.e., ideal anchorage balance) all well and good, and the simpler those appliances the better. The fact that whole units have to be removed, not halves or fractions of units, in combination with innumerable circumstantial issues, promotes situations where location and/or quantity of extraction space is not ideal.

Details of a case are included at this stage as a moderate example of how circumstances can lead to the non-ideal. It will be seen that first premolar extraction created space far in excess of requirements. Alternative extractions gave the prospect of difficult or lengthy treatment.

This case was treated erroneously, and an alternative method is suggested. Neither the actual treatment nor yet the suggested alternative, with which some may disagree, is as significant as the difficulties and principles of anchorage control that are raised. The case is included solely with a view to provide an illustrative example which, being practical, may make the problems more comprehensible to many than pages of theoretical argument (*Figs.* 3–5).

From the data given in *Figs.* 3–5 it will be seen that this patient had a near normal occlusal formation on a mild Class III dental base relationship. There existed a small discrepancy between bone and tooth tissue resulting in a minor degree of overcrowding. In the lower arch $\overline{|1\text{–}4}$ were affected by minor displacements and rotations, whilst the remainder of the arch was well alined. In the upper jaw a similar lack of space was confined in its effect almost wholly to $\underline{|2}$ which was displaced labially and rotated to a considerable degree. It was the position of this tooth that was the concern of the patient, who had, at the time, aspirations to television and film acting. There was no doubt that this tooth was more unsightly, particularly in overhead artificial light, than is suggested by the plaster models. The lips were kept firmly sealed at rest, and, on such facial expressions as smiling, lateral contraction took place a fraction of a second before elevation. The act as a whole produced a strong backward pull on the incisors, a feature worthy of more consideration

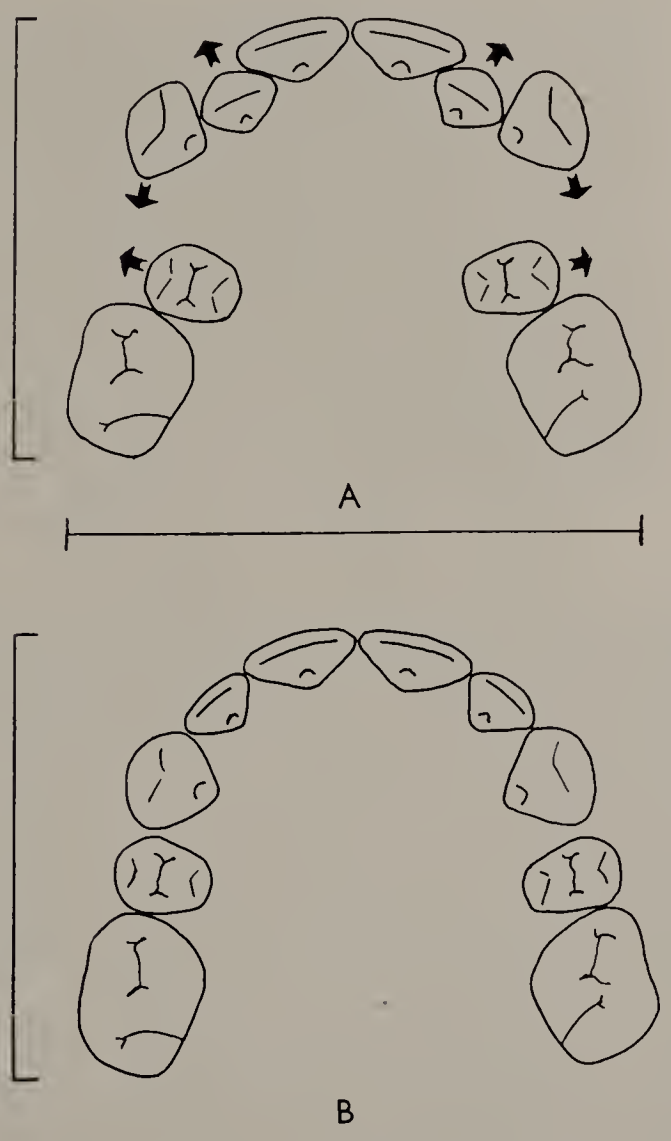

Fig. 2.—Simple or automatic space closure. If the displaced teeth in A are moved, by simple tilting in the direction of the black arrows, situation B results. The lack of strain on anchorage resulting from the type of tooth movement involved means that arch length and width can be easily maintained by a rigid appliance. The vertical and horizontal lines indicate that the main arch dimensions are unchanged during re-alinement. It will be seen in B that a small amount of residual space remains distal to the canines. This space would compensate for slight shift on the anchorage should it take place. Once simple tilting is replaced by a call for bodily movement there will be increased strain on anchorage. If, for example, the canines in A needed bodily retraction, extra anchorage would have to be found. More compensatory space would be needed or else anchorage shift prevented by extra-oral stabilization.

than was actually given at the treatment-planning stage.

The simplest cure of the patient's troubles seemed, at first sight, to be to extract a tooth tooth for extraction should be $\underline{|4}$. Unless retraction of $\underline{|4}$ was accompanied by considerable distal apical movement there would be eventual obstruction to retraction of $\underline{|3}$.

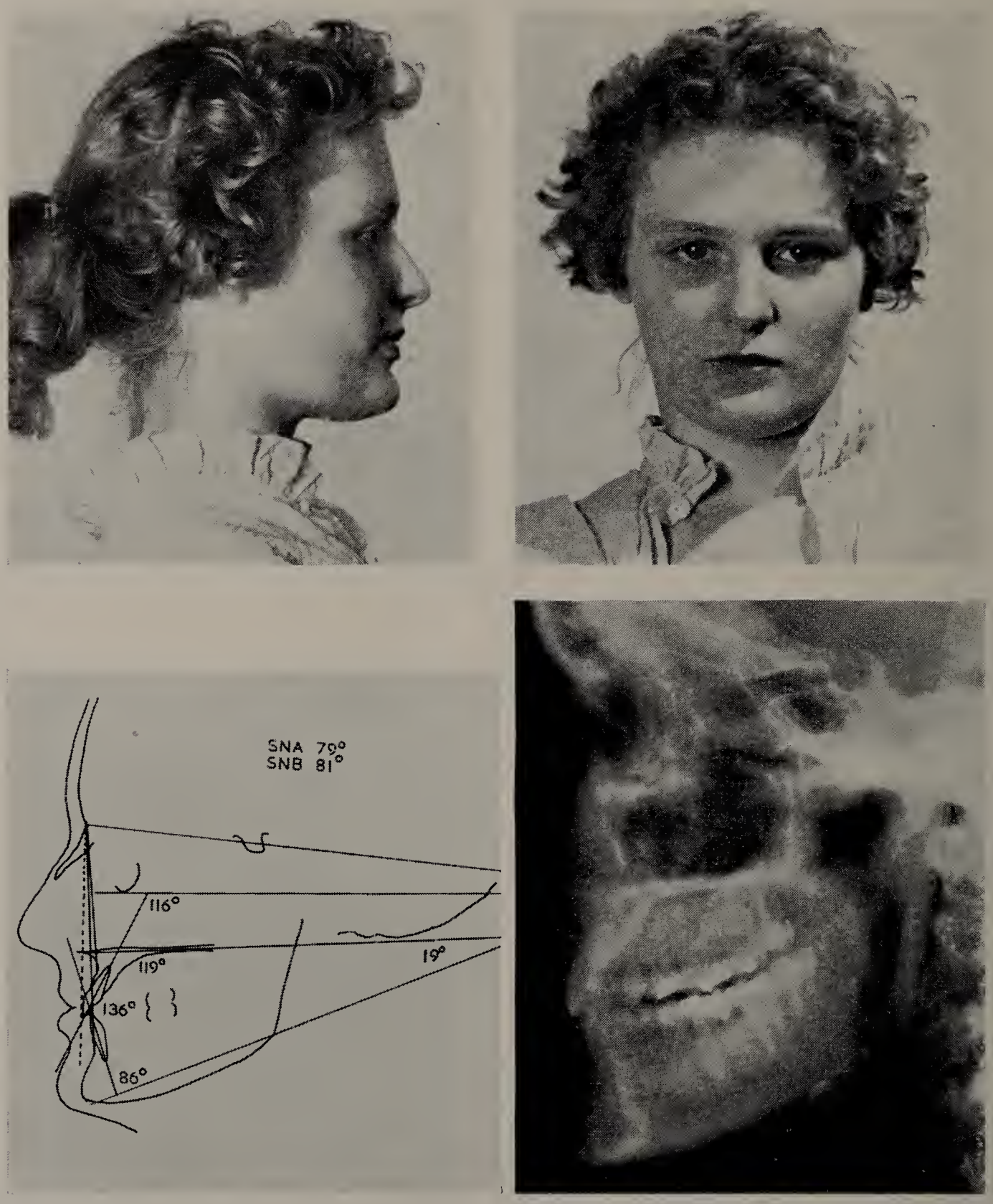

Fig. 3.—Profile and full-face photographs, tracing diagram, and lateral skull X-ray of patient whose treatment is discussed in the text. The patient was 22 years of age and was under treatment for 16 months. It was intended that the incisor relationship should not be altered upper to lower or that the profile should be changed. The dotted line from the N point to the labial surface of the upper central incisor and the angle formed with the SN plane was kept constant in successive tracings as a check on incisor position.

in the left upper buccal segment and to retract the teeth anterior to the site of extraction so that $\underline{|3}$ could be moved distally sufficiently to bring $\underline{|2}$ into alinement. The close proximity of $\underline{|34}$ apices strongly suggested that the

Close study of the plaster models showed a further hazard. If the left upper canine were retracted just the required distance to aline the lateral and avoid spacing, the canine would be brought into cuspal conflict with the mesially

and buccally displaced $\overline{|4}$. $\underline{|3}$ would thus be perched, with marked buccal inclination, on the mesiobuccal aspect of $\overline{|4}$ in a position of doubtful æsthetics and dubious stability. over deliberate anchorage shift were indicated, i.e., one of the full-banded systems. The full implications of the anchorage balance for the whole treatment were not properly assessed

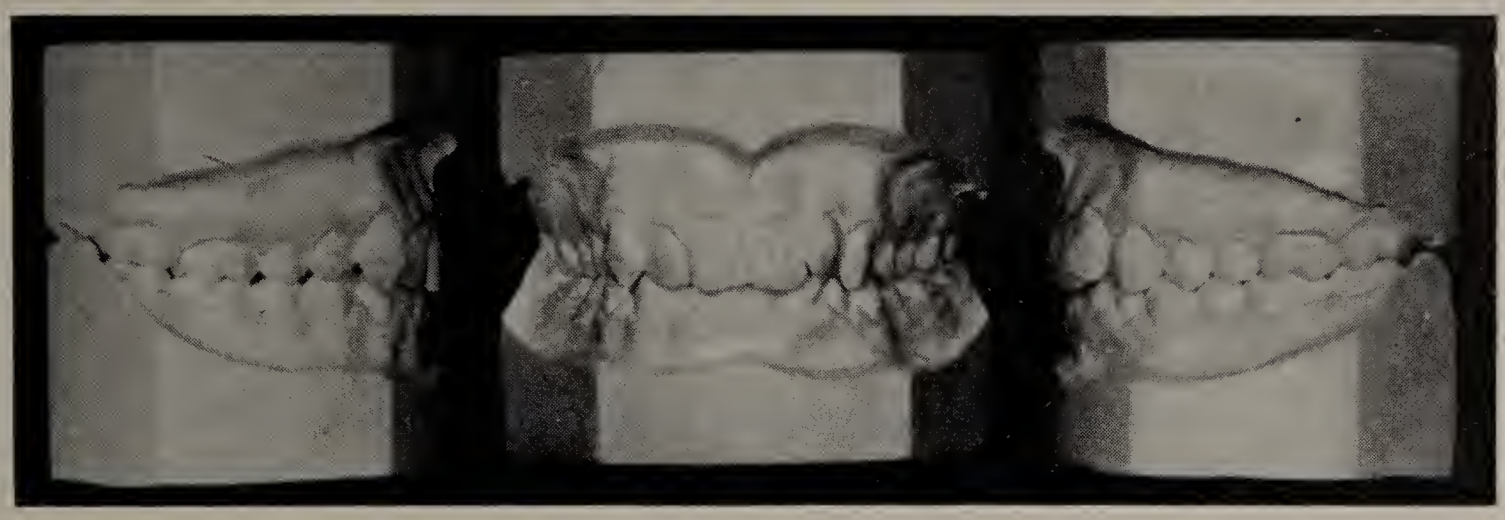

Fig. 4.—Models before treatment. Note position of $\underline{|4}$ apex.

Cuspal grinding, rearrangement of $\overline{|234}$ crowding, depression of $\underline{|3}$, were each considered as a way of overcoming the situation whilst avoiding further extraction, but were rejected on the grounds of either trauma, mechanical difficulty, or loss of æsthetic value. The $\frac{|4}{|4}$ were extracted.

With $\frac{|4}{|4}$ extracted, more than enough tooth tissue had already been removed to deal with the mild degree of overcrowding present. Nevertheless, with removal of first premolars unilaterally from both arches, one could anticipate a flattening of the anterior curvature towards the side of extractions with a centre-line swing in that direction. Since the upper right canine was somewhat prominent in the original occlusion, the above consideration would mean that in the treated condition it would be made to appear relatively more prominent, and therefore in order to maintain symmetry and avoid further shift of the upper centre line, already to the left, $\frac{4|}{4|}$ were also recommended for extraction.

Fig. 5.—Occlusal view of models before treatment.

The above represents the bare bones of the considerations which led to symmetrical first premolar extractions in this particular case.

It was realized at the outset that the extractions would create excess space, and that consequently non-rigid appliances permitting flexibility of movement and control at the outset, and treatment was started along what might be described as conventional lines.

The canine teeth of both arches were separately retracted against anchorage afforded by the posterior buccal teeth until space had been created for incisor alinement. No bodily

movement of the canines was necessary, only tilting, with the result that little strain was, or could be, placed on the posterior anchorage.

Such a treatment approach would be more applicable to a situation where there is little excess space available and measures such as moving teeth individually or in pairs are indulged in to reduce strain on anchorage. Here the reverse was indicated. Had these measures been persisted with in this type of situation the following position would have been created (*Fig.* 6 B): Well-alined upper and lower labial segments correctly related and within muscular balance separated from the posterior segments by half or more of the original extraction spaces, the canines having been moved into no-man's-land.

Anchorage must be found against which to bring forward these posterior segments. If the labial segments are used simultaneously, a double retroclination or "dished in" appearance will result, which would be unæsthetic and probably unstable within muscle action.

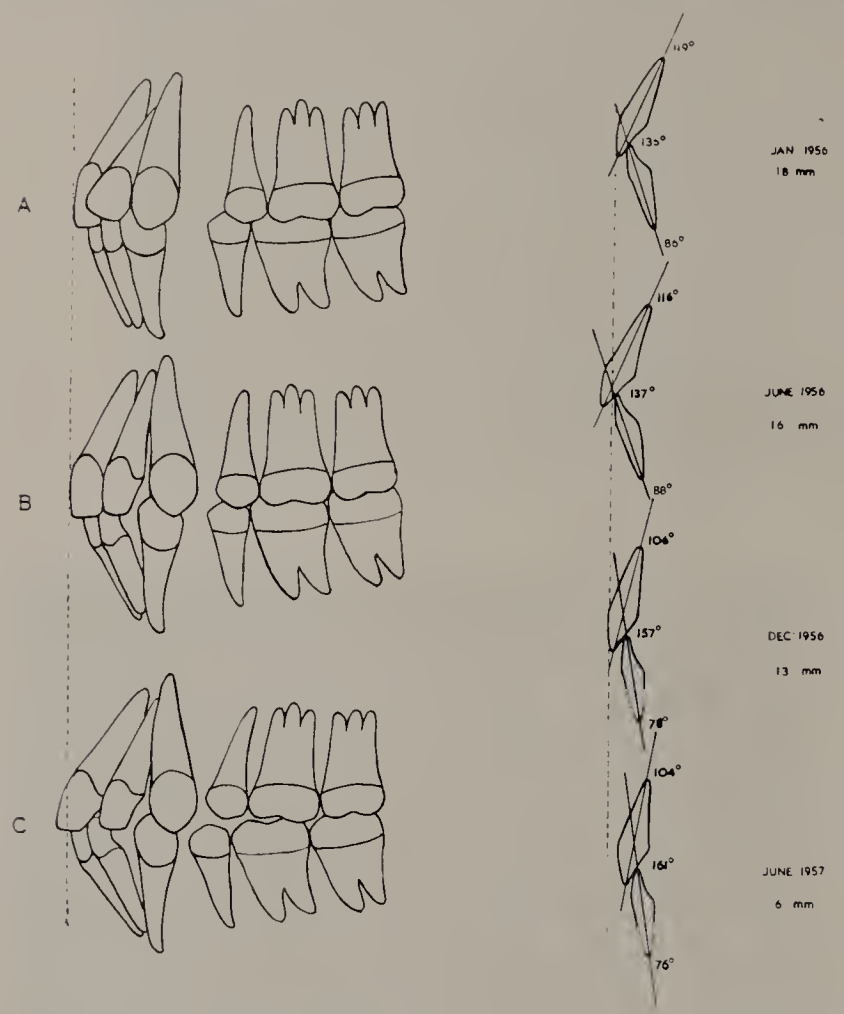

Fig. 6.—A, Represents the original condition following extraction of first premolars and before tooth movement. B, Represents the situation that might have occurred following simple retraction of the canine teeth and alinement of upper and lower anteriors. The incisor relationship is correct and within muscular equilibrium, but separated from the posteriors by considerable residual space. C, Represents the situation that did occur following canine retraction. The inadvertent proclination of the labial segments offers limited anterior anchorage.

Changes that took place to the incisal relationship during treatment are represented in the right-hand column. The total amount of space present is also indicated for each stage. Bodily control of the incisors was not introduced until January, 1957.

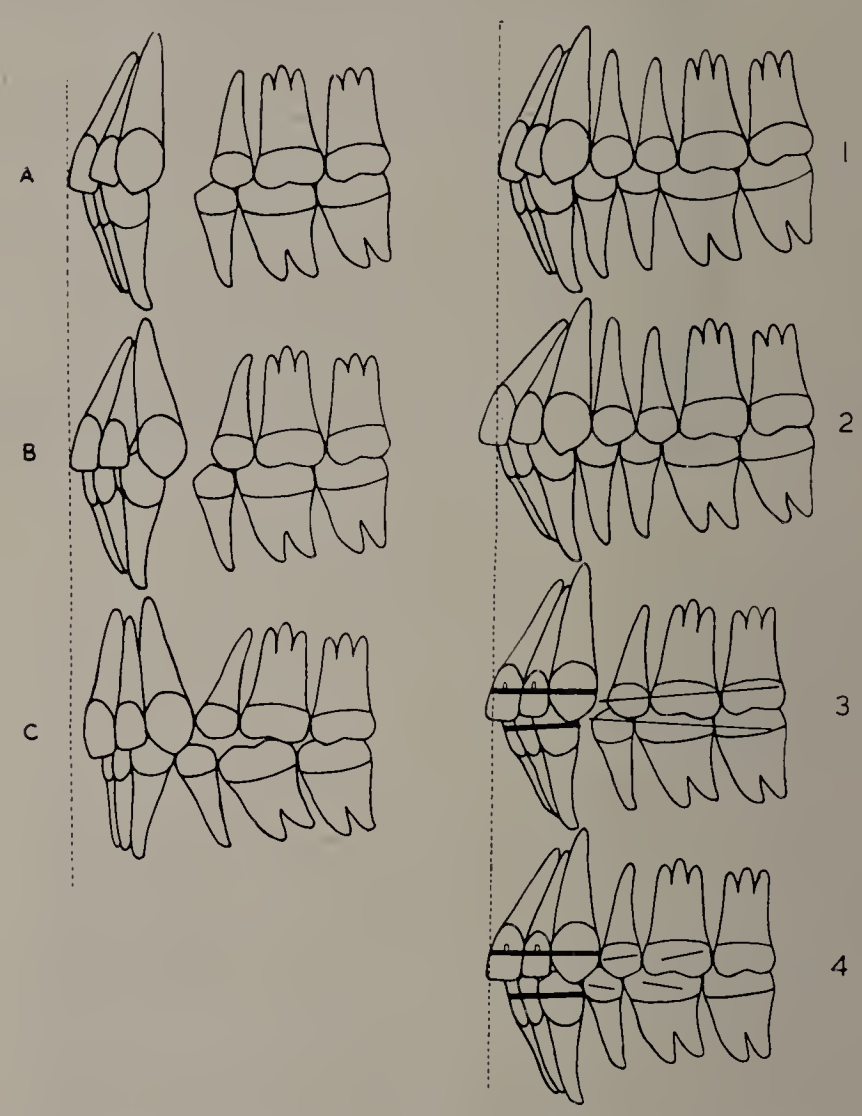

Fig. 7.—A–C show arbitrary space closure without use of anchorage control. 1–4 show the use of anchorage control principles. Begg type, spurred-round archwire or rectangular wire anteriorly. Posteriorly tip backs in various forms combined, in the case of round archwire, with a degree of offset.

Two ways of overcoming this problem might come to mind. First, to stabilize the lower arch with a rigid appliance so that the lower labial segment could give support to the upper whilst the latter was used to afford anchorage to close the upper spacing. Then to use the upper arch, as a whole, as anchorage to close the lower spacing. This would be a slow procedure compared with any method of simultaneous closure, if such could be devised.

Secondly, there is the possibility of providing extra-oral anchorage. It seems unlikely that any such arrangement to close all spacing

simultaneously could be anything other than a little more cumbersome than usual. If these two methods are rejected, one is back in the mouth in search of anterior anchorage, which apparently does not exist.

Returning to the case, errors did not finish at the treatment-planning stage. Through lack of foresight, little interest was shown in the exact positions of the labial segments during initial tooth alinement. These were considered the concern of a later period of treatment and allowed to wander. As it so happened, they were included in the band-up and became unintentionally slightly proclined (2 mm.). Thereby some limited anterior anchorage was inadvertently provided to help overcome the threatened impasse. The posterior teeth could be brought forward using the anterior teeth for anchorage simultaneously until the latter had been retracted to their correct inclinations (*Fig.* 6 C). This resistance would have been negligible if plain round archwires were used, but by the use of archwires that were rectangular in cross-section, close fitting in all brackets canine to canine, the anterior teeth were prevented from tilting and near bodily movement compelled, thus greatly increasing their anchorage value. By resorting to these means in the nick of time, success very nearly resulted.

So nearly was success achieved that it was not difficult, reviewing this case in retrospect, to see where treatment-planning went wrong, and how, in future, in this type of case, one could organize for controlled, intentional, and complete success.

The penalty for incomplete treatment-planning was nearly paid. It should have been envisaged that anterior anchorage would have to be available in quantity if the posterior teeth were to be brought mesially enough to support the labial segments in their original positions and eliminate unsightly spacing (*Fig.* 7).

Extraction of the first premolars might have been delayed whilst commencing the alinement of the upper and lower anteriors by proclination. Once the required degree of proclination for forthcoming anchorage needs had been established the first premolars would have been removed and anterior alinement completed. The permanent canines with their large root areas should have been kept in the anterior anchorage and not separately retracted. The anchorage value of the whole of the labial segments, thus proclined, and inclusive of the canines, should then have been stepped up by the use of rectangular wire or Begg-type vertical loops. Inter- or intra-maxillary closing forces should then have been applied between the anterior and posterior segments. Since the former are compelled to move bodily, sufficient resistance would be available to close space largely from behind without the need to promote excessive initial proclination.

Once the closing forces have been applied between the prepared anchorage and the posterior teeth, the object will be to so utilize and alternate inter- and intra-maxillary forces that the labial segments are gradually drawn back towards their correct relationship and equilibrial position and actually arrive there at the precise moment that final space closure occurs. Failure to gauge this exactly will result in either residual proclination or a proportion of double retroclination. It might be mentioned in passing that the prejudging of the anchorage balance to be created by the above measures, at best never easy, is often further complicated by the difficulty of assessing relative muscular influence of lip and tongue on the labial segments.

Thus far, consideration of control and preparation of anterior anchorage has predominated.

Attention must now be given to the behaviour and control of the posterior segments during space closure.

To this end it would be helpful to describe in a little more detail the final mechanical method belatedly employed in the treatment of the patient described earlier. This method is not intended to represent ideal mechanics but will illustrate certain principles.

The archwires used for the space closure stage were edgewise rectangular 0·022 × 0·020 in. To avoid the need for imparting passive torque, promote simplicity of handling, and reduce posterior resistance, these

rectangular archwires were rounded in the buccal regions posterior to the canine brackets. Closing loops were then bent in and the subsequent handling of the buccal teeth was by round archwire approximately 0·017 in. By the use of such an archwire some control was kept over anterior anchorage whilst permitting a degree of tilting of the posteriors

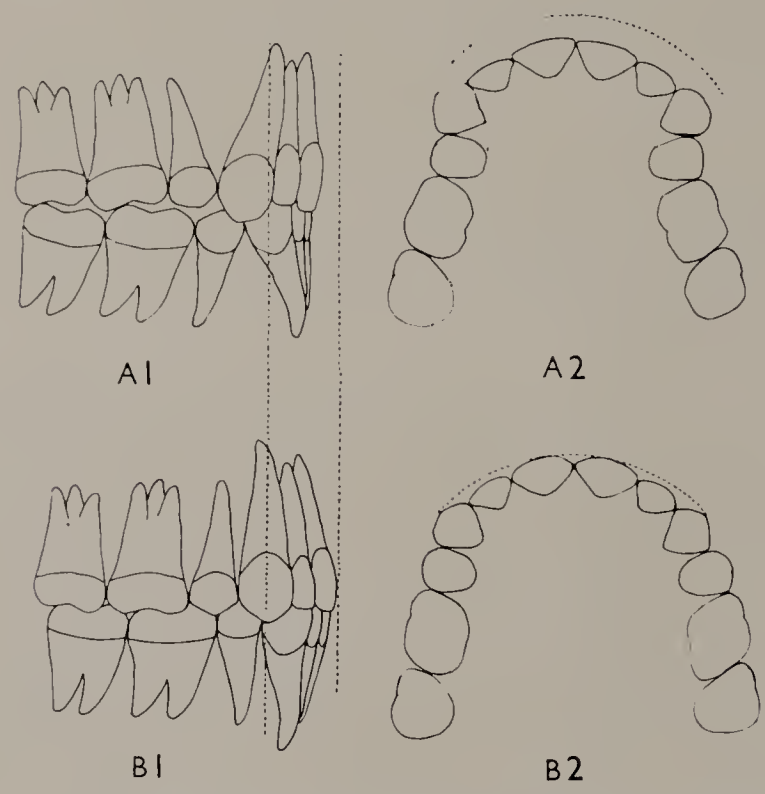

Fig. 8.—A1 and A2 show lateral and occlusal views of uncontrolled movement during space closure. Over-retroclination of labial segments and loss of posterior occlusal contact together with lingual rolling are also shown. B1 and B2 show the desired objective.

during mesial movement. Nevertheless, limited control over the axial inclinations of the posteriors was desirable.

The direct mesial pull on these teeth with round archwires causes them to tilt and roll mesially and lingually with apical transference to the buccal of their original positions, and in the process, occlusal contact will be lost. On discontinuation of retention this undesirable state of affairs will either remain, gradually improve with the passing years, or, much more commonly, space will re-open by the posteriors uprighting on their apices in regaining occlusal contact, the length of the apical base being the deciding factor (*Fig.* 8).

Steps must be taken to offset the tilting and rolling if round archwires are used. This is done by a mild degree buccal tip back and offset. These are deliberate adjustments carried through with a view to maintaining the crowns of the posteriors nearer to occlusal contact and rolling the cheek teeth buccally during mesial movement. In other words, a mechanical counter to the natural tendencies (*Fig.* 9).

The buccal tip back, if increased, can also be used to move the apices of the cheek

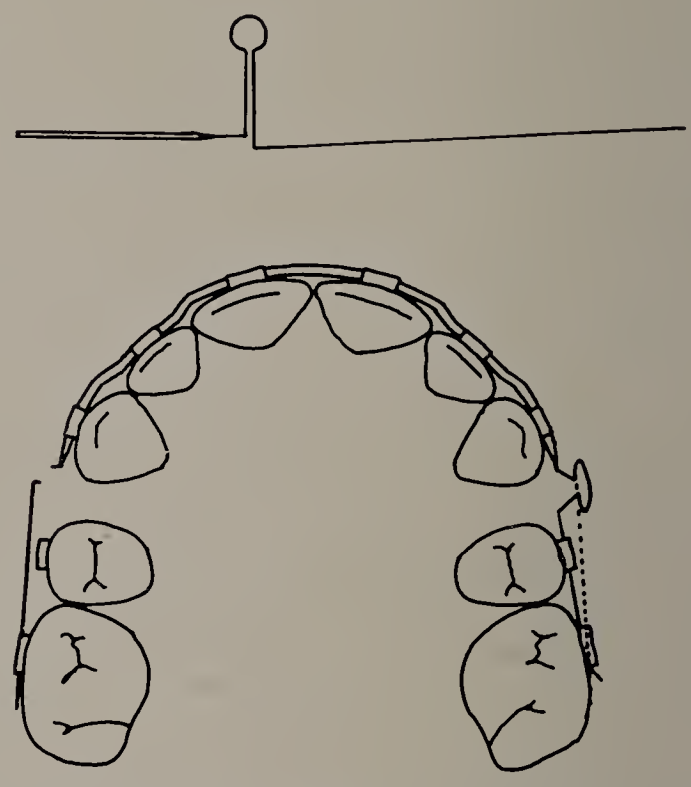

Fig. 9.—The part-rectangular, part-round archwire showing lateral and occlusal views. The posterior section of the archwire is adjusted by tip back and offset to produce a direction of force which directly counters the natural tendencies of the posterior teeth to roll lingually and tilt out of occlusion.

The appearance of these undesirable effects if left uncontrolled is shown in *Figs.* 7 C, 8 A1, A2.

teeth mesially and obtain uprightness. It should be realized in the latter connexion that if the tip back and offset are mild, little more than control of rolling and rotation results. Once the tip back is further increased to cause active mesial movement of the posterior apices, resistance will be immediately increased. The apices will be driven mesially whilst the crowns tilt distally, producing a form of dynamic anchorage useful as a counter to any force pulling forward against the posterior segment.

Such posterior resistance was not called for in the case herein described, but would be of great value, for instance, as counterbalance to Class II intermaxillary pull (final models, *Fig.* 10).

It should be acknowledged that the part rectangular, part round archwire technique outlined above is a deliberate simplification of method and is undeveloped when compared with the full edgewise and other established techniques, for example, Dr. Begg's round archwire system. Nevertheless, all these techniques employ the same fundamental principles.

Each technique varies in detail of components, adjustments, method, and handling, all of which affect anchorage judgement. Each separate technique must be the object of detailed study and practice if the orthodontist is to become master.

It is certainly not intended that the impression be left that these fundamentals of anchorage control are confined in their usefulness to certain Class I conditions which happen to have become complicated by a combination of such unusual circumstances as earlier described.

On the contrary, the concept of anterior or posterior anchorage build up is fundamental to control and can be applied to any condition that can be foreseen to need elimination of excess space, whether in one arch or both, or in what classification of malocclusion, and, indeed, whether or not actual space closure is achieved.

To give just one example, comparison will now be drawn between the anchorage balance deliberately contrived in the previous case-history with that which is found ready-made in the Class II, division 1 treatment problem.

It was shown in the Class I condition how a labial segment could be made to offer increased resistance by first deliberately proclining and then compelling bodily movement. The increased anchorage was then used to close unwanted space (*Fig.* 11).

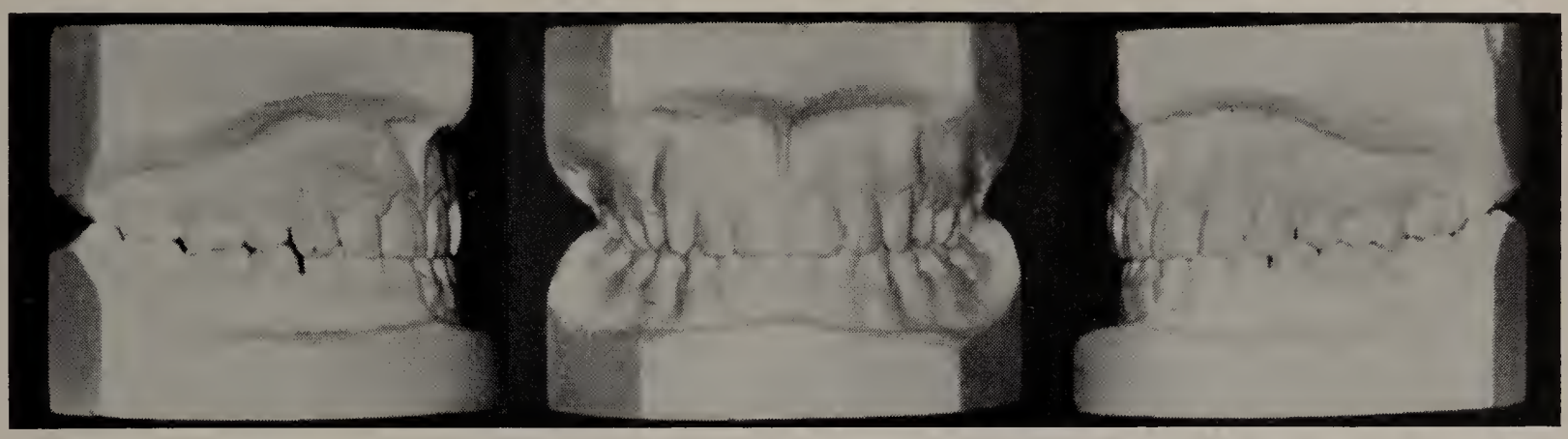

Fig. 10.—Full-face and lateral views of case after completion. Other data have been omitted since neither the actual treatment nor the suggested alternative are of true importance. The case is used as introduction to mechanical anchorage control methods used with the multiband round archwire appliances.

In the Class II, division 1 condition the upper labial segment is found already proclined. If, in addition, there is a call for bodily reduction of the overjet, or for avoidance of forward swing of upper incisor apices during retraction, rectangular or Begg-type spurred round archwire will have to be used to obtain the necessary control. One, then, has the proclined segment compelled to move bodily and, as has been seen, such resistance will cause anchorage shift to any intra-oral force.

If, therefore, an intra-maxillary force is applied between the upper labial segment and the upper posteriors, space for the overjet reduction will be lost from behind. If an inter-maxillary force is used between the upper anteriors and an intact lower arch, the entire lower arch will move mesially with the undesirable proclination of the lower labial segment, resulting in probable ultimate lower arch relapse. If space is created which is sufficient to compensate for lower anchorage shift, the teeth of the overjet can be retracted into the upper premolar spaces by pitting them, by Class II mechanics, against the lower posteriors. In this instance, marked tip-back bends are incorporated into the posterior of the lower archwire to cause increased resistance to the elastic pull by

driving the apices of the lower posterior teeth mesially. The upper posteriors are stabilized against mesial drift by similar but milder tip backs. The lower labial segment is stabilized against possible proclination that might result from posterior bracket to archwire frictional resistance by availability of an intra-maxillary force. The posterior tip backs not only afford control and temporary increase of anchorage, but also cause gradual repositioning of the apices into desirable locations for case completion.

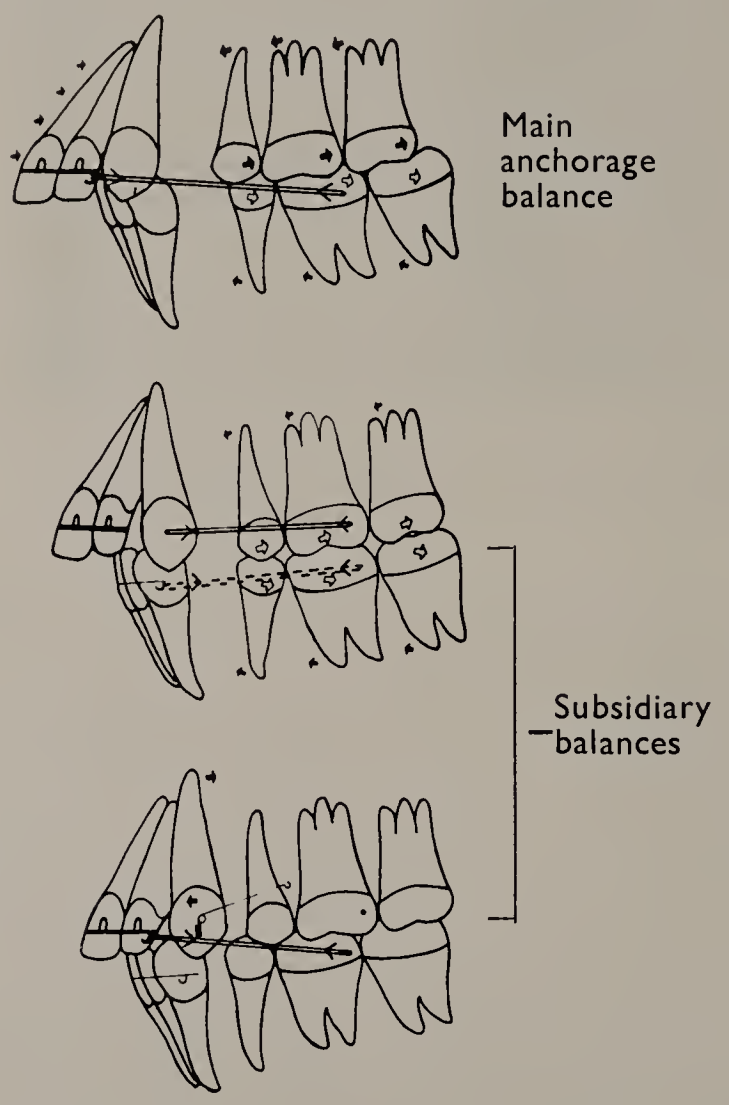

Fig. 11.—Arrows show anchorage control caused through archwire adjustments. Black arrows show positive movement, the outlined arrows where this movement is countered by another force. Subsidiary and main balances will be run concurrently. The subsidiary balances shown above relate to canine retraction and apical re-orientation, and to the need for availability of lower intra-maxillary traction to prevent incisor proclination due to posterior bracket to archwire locking that may occur during use of Class II mechanics.

Just as in the Class I case so here in the Class II, division 1 the object will be so to adjust the forces that the labial segments are returned to their correct positions at the precise moment that spacing is eliminated in both arches.

Throughout the observations on the methods of multiband therapy, bodily control of a tooth has been referred to as producing increased anchorage resistance. This is true, but it should not be thought that the act of preventing a tooth from tilting automatically transforms the supporting tissues into concrete, or that causing distal tilt to posterior teeth by tip-back bends gives increased resistance by virtue of the new angulation.

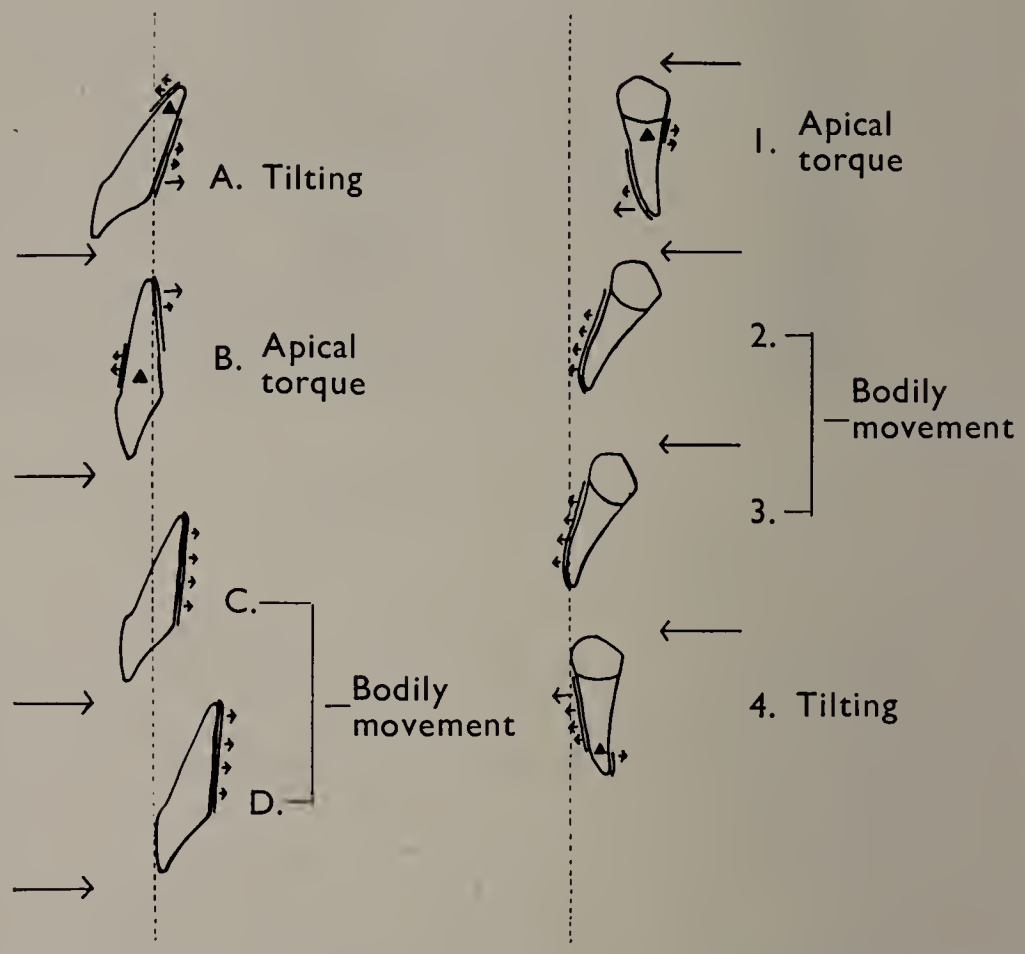

Fig. 12.—Illustrates the retraction of an upper incisor and forward movement of a lower premolar towards a given line. Differential pressures are used in two different orders, both with a view to obtaining maximum anchorage value from the tooth concerned. The small arrows indicate distribution of pressure and the small black triangles the pivotal points.

Fig. 12 is appended to show how the maximum anchorage obtainable from any given tooth stems from the root area and the total distance that root can be compelled and permitted to move bodily through bone. The full bodily shift can be brought about either by a gradual, even distribution of pressure over the entire length of the root, or by applying pressure at one end of the root and then at the other. In bodily movement, or where apical torque is applied, the crown is prevented from the rapid change of position that occurs when tilting is permitted. Such control over the

crown position represents a gain in space and time occlusally—a fact which can bc turned to practical advantage.

SUMMARY

The ideal situation in mechanical therapy is where circumstances allow, or by thoughtful treatment-planning can be made to allow, for full reciprocity of appliance action whereby both action and reaction are beneficial to the ultimate objective. In this way wastage of time and appliance effect is reduced to a minimum. This means the provision of an ideal anchorage balance which in turn will mean that, in the extraction case, these be carried out at the right time, the right place, and provide the right space.

The judgement of such ideals will depend on the orthodontist's ability to assess all factors pertaining to anchorage, whether natural or artificially created. Unfortunately, he will find, despite planning, that the perfect balance is elusive, and that all too frequently circumstances arise to render impossible perfect harmony between any selected extractions with any appliance method. Occasionally, circumstances prevent extraction in the ideal location for balance. This imbalance leads to protracted treatments, either by increasing the quantity of tooth movement, or increasing the difficulty of mechanical control, or both.

More commonly, the ideal balance cannot be obtained because one is compelled to remove whole units. The amount of space rather than the location is wrong. The orthodontist will, in these circumstances, be confronted with one of two mechanical problems. When faced with space barely adequate for his needs, his problem will be the preservation of anchorage stability. Whcn space created is substantially in excess of his needs, the problem will be one of controlled elimination of the unwanted space.

Appliance systems tend to fall into two groups, which by virtue of basic design lcnd themselves to the solving of these several problems. These groups are not fixed and removable. Such aspects of design have no true significance. The groups could more accurately bc described as "rigid" and "flexible".

Removable and labio-lingual appliances are examples of the rigid variety; the rigidity being imparted through a framework or "body" of stout wire or acrylic. Thesc types lend themselves to maintaining arch length and width and anchorage stability. They are also comparatively limited in their capacity for simultaneous tooth movement, particularly where control over the long axes of the teeth is concerned. Through reduction in quantity of simultaneous direct action and use of bulk anchorage, the reciprocal effects are limited and slow to form. The direct and indirect action of these appliances are, therefore, not difficult to interpret in advance, and little excess space will be needed to compensate for the slight anchorage shifts likely to occur. Furthermore, in cases where no shift whatsoever can be permitted, extra-oral traction counterbalance can be added to the rigid type appliance without curtailing efficiency or reducing the potentiality of the apparatus for simultaneous tooth movement.

The significance of the frequent reference to the potential of appliances for simultaneous tooth movement lies in the influence this has in reducing overall treatment time. Treatment periods are shortened not by moving individual teeth more rapidly, but by moving more teeth simultaneously in the appropriate directions.

When confrontcd by the problem of closure of substantial amounts of excess space, the simple rigid appliance is at a disadvantage. It becomes difficult with this type to move part of the anchorage more than another, and there is lack of control over the long axes of the teeth. More flexibility is required throughout the dental arches so that groups of teeth can be moved precise distances quickly, whilst at the same time providing better control to each tooth individually. The flexible types of appliance contend with these requirements and provide the obverse side of mechanical tooth movement. What has been said of the rigid variety can now be reversed.

The multiband systems, possessing no wire or acrylic "body", provide anchorage flexibility and are suitcd to dcliberate indepcndent

movements rather than general stabilization. Their potential for simultaneous tooth movement is unrestricted, and control over the long axes of individual teeth is provided. Because of this latter factor, these appliances are commonly used to effect rotations and change of apical positions, and to control bodily movements—the very tooth movements likely to place the greatest strain on anchorage. Marked shift of anchorage can often be anticipated with the flexible appliance, and excess space to compensate must be provided in the extraction case. Attempts to maintain anchorage stability by extra-oral traction counterbalance in association with multiband appliances may well be only partially successful and may even damage the apparatus. This is particularly true of the fine, round archwire techniques.

The foregoing material is intended to suggest that rigid appliances are seen at their least efficient when attempting to close excessive residual space. The flexible variety are at their least efficient in company with bare adequacy of space, and need excess space for full efficiency. A hint has also been dropped that it is the anchorage judgement side of multiband therapy that is difficult, rather than the technical aspect. Unhappily it is not possible within the scope of this paper to draw conclusions. Due reflection may persuade the thoughtful reader that these could be numerous.

Finally, should the views expressed herein be read with steadfast disbelief, it is the author's sincere hope that his attempt to dissociate fundamental appliance principles from technique detail will not go unnoticed.

The diagnostic side of orthodontics was, until the realization of the basic importance of the variation of bone and muscle patterns, a conglomeration of uncorrelated symptomatic material. On the practical side of the subject some similar understanding on basic issues is still required. The appliance field will remain a pool of multitudinous, uncorrelated machinery to many a practitioner until more emphasis is laid on fundamental principles rather than on individual methods and techniques.

DISCUSSION

The President said that the paper gave some idea of what students were up against! He invited Mr. Adams to open the discussion on the paper.

Mr. C. P. Adams said that the problem of residual spacing at the end of orthodontic treatment, in which teeth had been extracted, was one that worried everyone from time to time. Those who used removable appliances might worry because they did not have fixed appliance technology at hand. On that point he agreed with Mr. Fletcher, in that distinction between the terminology regarding appliances—rigid appliance versus flexible appliance—was an important kind of distinction. The only caution he would add was that in spite of the multiplication of terminology, perhaps they could agree on that distinction in a suitable form.

Those who used removable appliances or rigid appliances felt worried because they had not the flexible type at their command, and those who used the flexible type might feel uneasy because they were so well-equipped. The availability and capacity to use multiband appliances might carry with it a kind of implied obligation to close every space in sight, regardless of all other considerations.

He agreed most heartily with Mr. Fletcher's dissociation of treatment rationale from technical means and his insistence on the need to think clearly first of all about what was to be done and then about the way in which to do it. The idea that a philosophy, doctrine, or rationale of treatment implied unavoidably the use of specific technical means was most confining, and if devoutly followed, led, in time, to a blindness to the real issues that were involved.

Spacing was a natural condition in some dentitions, and when it was found to occur, in those circumstances, it was accepted. Furthermore, such spacing usually occurred in the labial segments where it was most easily seen. The difficulty was that while the responsibility for the occurrence of natural spacing could not be laid at the door of the orthodontist, space left over at the completion of treatment which involved extraction of teeth could be pointed to as an undesirable by-product which, it might be suggested, had to be got rid of at all costs, particularly if such spacing was visible in everyday life.

As Mr. Fletcher pointed out, at the planning stage of treatment there should be consideration of the relationship of the amount of space that would be created by the removal of teeth to the amount of space that was actually required for the final repositioning of teeth mesial to that space. From that would follow the estimation of whether there was need or not to close residual space from behind to produce interproximal contact.

The proportion of cases in which the amount of space created by extraction exactly matched the amount of space required for the alinement and repositioning of the arch mesial to the space must be quite small. Why was it, therefore, that consideration of space closure mechanically had not featured more in orthodontic literature in the British Isles? There were two answers to that question. One was the belief that if it was possible to produce a

satisfactory functional and æsthetic result without multiple and extensive tooth movements, there was much to be said for doing so. Secondly, the tendency for teeth in the buccal segments to move forward if relieved of their interproximal contact in front was well known, and reliance on that tendency, which persisted for a considerable time, was not always ill-founded, and it provided the necessary space-closing factor in many cases.

The question of space closure following extraction in the buccal segments could not be considered without reference to the site of extraction, although sometimes, when extraction was mentioned, extraction of the first premolars was meant. It was, however, misleading to discuss the control of space closure as a general topic and only to make reference to the closure of the first premolar spaces. The extraction of other teeth in the buccal segment had long been practised, and if extractions of necessity because of caries were ruled out, teeth other than first premolars had been selected for extraction largely because of the problem of residual space. The advantages of the removal of teeth farther back than the first premolars were that, if space was left in the end, it would not adversely affect the result æsthetically. Secondly, the likelihood of space remaining at all was very much reduced. The corresponding disadvantages of tooth misplacement in the buccal segments by rotation and tilting might occur, but those might be dealt with, if thought necessary, by multiband appliance therapy, and at that stage a choice of treatment or no treatment for correction of such rotations was still open.

The subject Mr. Fletcher had put before them concerned a situation that every orthodontist had to face from time to time, and Mr. Fletcher had done good service in bringing the matter to discussion in the Society.

Mr. F. Allan said he was particularly interested in the paper because space closure on the whole was not taken very seriously. If there was already a space existing in the lower arch and there was crowding in the anterior labial segment, it was not considered necessary for dental fitness to move those teeth into the gap.

Another thing about closure of space was that one saw spacing anteriorly in many cases with crowding and overlapping persisting posteriorly unless these spaces were closed. This had to be considered from the point of view of failure of treatment after a number of years.

Mr. J. H. Hovell said that Mr. Fletcher's paper contained a mixture of common-sense opinions with quite a lot of technique. There were two problems in space closure: one was to close the space, and the other was to make sure that, when it was closed, it stayed exactly as it had been put. Mr. Fletcher had pointed out that by uneducated techniques in which anchorage was not fully considered, when the incisors were rotated and cheek teeth tilted, the spaces were apt to open up again when treatment was finished. If a space was going to open up after it had been closed, it would have been better not to have closed it at all from a point of view of oral health. He thought that a lot of closure of spaces was undesirable unless they were properly closed. The whole point of the tip-back bends on buccal segments was that, when the appliances were taken out, those teeth, by occlusion, tended to be tilted forward a bit, so the space closure remained, the cheek teeth were tilted forward by occlusal forces against the labial segment, and space closure was maintained. It did not open up, and one did not get the frightful result when a space was closed up and opened up a little bit. That was the main disadvantage of poor space closure.

He thought that Mr. Fletcher had debunked slightly the tip-back bend in providing anchorage, and pointed out that it was the sum total of the movement of the teeth that really mattered, and not when it took place. They had a lot to learn from Mr. Fletcher and he thanked him for his paper.

The President said that it seemed to him that the main lesson that might possibly be learnt from the paper was the importance of trying to avoid treating cases on a "catch-as-catch-can" basis. The emphasis that Mr. Fletcher had laid on the overall planning right from the outset had been very valuable. He well remembered that, as a young general practitioner orthodontist, how often one did a year's treatment and then did not know what to do in the second year. One got a certain way with the case, and then had to try to dream up something to finish it off.

Mr. Fletcher had shown very clearly what an unwise process that was.

Professor G. E. M. Hallett said that, arising out of the case shown by Mr. Fletcher, there seemed to be a difference in size between the teeth on the one side and the teeth on the other. Mr. Fletcher had not referred to it, and it might have been an optical illusion, but there seemed to be a difference in crown morphology between the molars and the premolars on the more crowded side. The molars on the left side seemed to be larger with an interestingly different crown morphology from those on the right-hand side. He would be interested if Mr. Fletcher had any comments on these observations.

Mr. D. J. Hartley applauded Mr. Fletcher's analytical approach to the problems of space closure. It was a fundamental method of approach which might be much more widely applied to orthodontic problems. He was a little puzzled on one point, and hoped Mr. Fletcher could help him. Why had he taken the trouble to round the posterior sections of the rectangular wire, then to be faced with the problem of lingual rolling of the premolars and molars? Surely, had he not rounded the wire, that problem would not have arisen.

Mr. Fletcher, replying, said that he felt privileged to have Mr. Adams to open the discussion.

Amongst the observations that he had made was the matter of space closure through natural causes. Mr. Fletcher said that this was a well-recognized phenomenon, and occurred readily in cases that happened to possess appropriate size of dental base and favourable individual apical positions of the teeth. He had, however, deliberately ignored this aspect as too obvious and had concentrated on space closure in less favourable circumstances.

Mr. Fletcher, continuing, said that he had not meant to be misleading by alluding only to first premolar extraction. Naturally, if alternative extractions provided a more favourable balance of anchorage this would be done in preference to facing mechanical complexity. Nevertheless, the basic problem of providing too much or too little space would still arise.

With regard to the closure of space anteriorly having a more important link to facial æsthetics than residual buccal spacing, Mr. Fletcher agreed that this was so and might alter mechanical detail but not the fundamental problem.

On the subject of whether the anchorage resistance of a labial segment would remain the same even if it were not first proclined, Mr. Fletcher said resistance would always be the same for bodily movement of the same

teeth over the same distance. He thought that the benefit of proclining was one of easing the mechanical aspect of initial alinement and represented a gain in time and space occlusally.

Replying to Mr. Allan, Mr. Fletcher said he doubted whether some authorities would take such a perfectionist view of space closure as he had. They could scarcely bear the cost of the work involved, and would have to rely more on natural space closure and accept residual space wherever the individual merit of a case permitted.

Answering Mr. Hovell, Mr. Fletcher said that space re-opening after treatment was always damaging to an orthodontist's pride in achievement, but not necessarily detrimental to the result as a whole. The important factors preventing such relapse were in adjudging correctly the equilibrial position of the segments, particularly the labial, the re-adjustment to proper axial inclination, and the maintenance of occlusal contact.

Mr. Fletcher thanked the President for adding emphasis to his remarks on treatment-planning. It was of incalculable value to have the stages of treatment envisaged from start to finish. One should know what was going to happen and not rely on visit-by-visit inspiration.

In thanking Professor Hallett for his observations Mr. Fletcher said that he had not noticed any difference in crown morphology in the case reported, but would check on this point.

Mr. Hartley had asked why the rectangular archwires used in the treatment of the patient featured in the case report had been rounded in the buccal regions. Not to have done so would have resulted in the use of full edgewise technique involving such matters as the imparting of passive torque requiring time and great accuracy. The use of part-round archwires avoided this. It should be remembered that the precision of the edgewise mechanism must be matched by immense accuracy on the part of the operator. This happy union all too seldom occurred. Round archwire techniques had their shortcomings, but ways and means were being found to counter these. The fine round archwire technique propounded by Dr. Begg, for example, seemed scarcely less effective than edgewise and in due time some such method may prove the simpler of the two.

ANGLE'S CLASS II, DIV. 1 AND CLASS II, DIV. 2
A COMPARISON OF STABILITY AFTER TREATMENT

By **H. L. LEECH**, B.D.S., F.D.S., D.Orth. R.C.S.

Some six years ago I presented a paper to this Society on the relationship between a pair of identical twins, one with an Angle's Class II, division 1 malocclusion, and the other with Class II, division 2; two years later I showed the results of their orthodontic treatment. They have now been seen again three years and three months after all appliance treatment

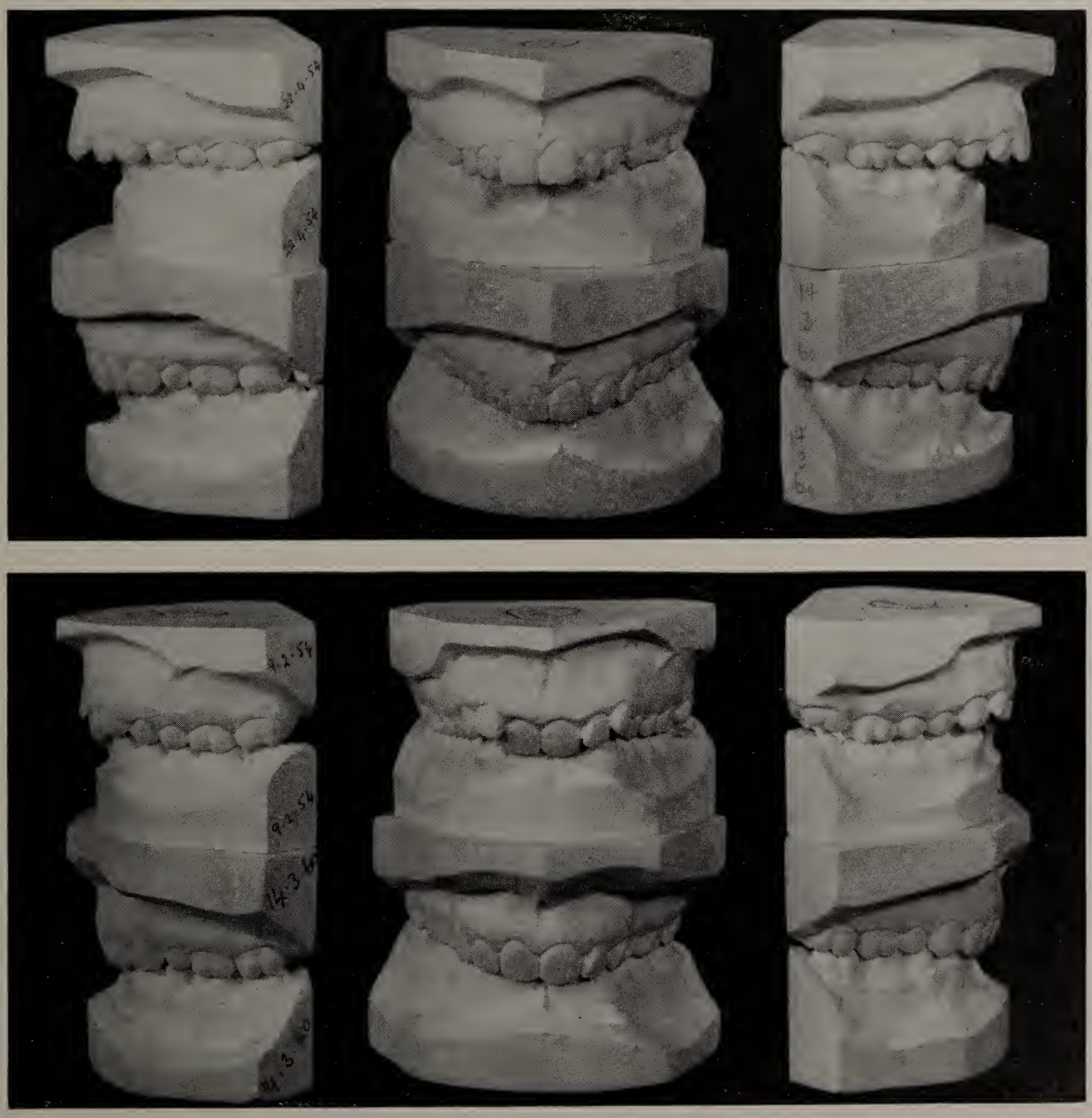

Fig. 1.—Showing the original and final models of each twin.

A short communication given at the meeting held on March 13, 1961.

was completed, and I hope that the findings prove to be of sufficient interest to warrant this final short communication.

The treatment explained more fully in one of the previous papers consisted of the extraction of the $\frac{4|4}{}$ and $\frac{5|5}{}$ and inter-maxillary traction, and produced the results shown briefly in *Fig.* 1.

continued to move palatally from 93° to the Frankfort plane to the present 90°, whilst the lower incisors were overproclined during inter-maxillary traction from 94° to 107° and relapsed back, not as far as their original position of 94°, but to 103°, due, no doubt, to the upper incisors now taking some of the distal thrust of the lower lip.

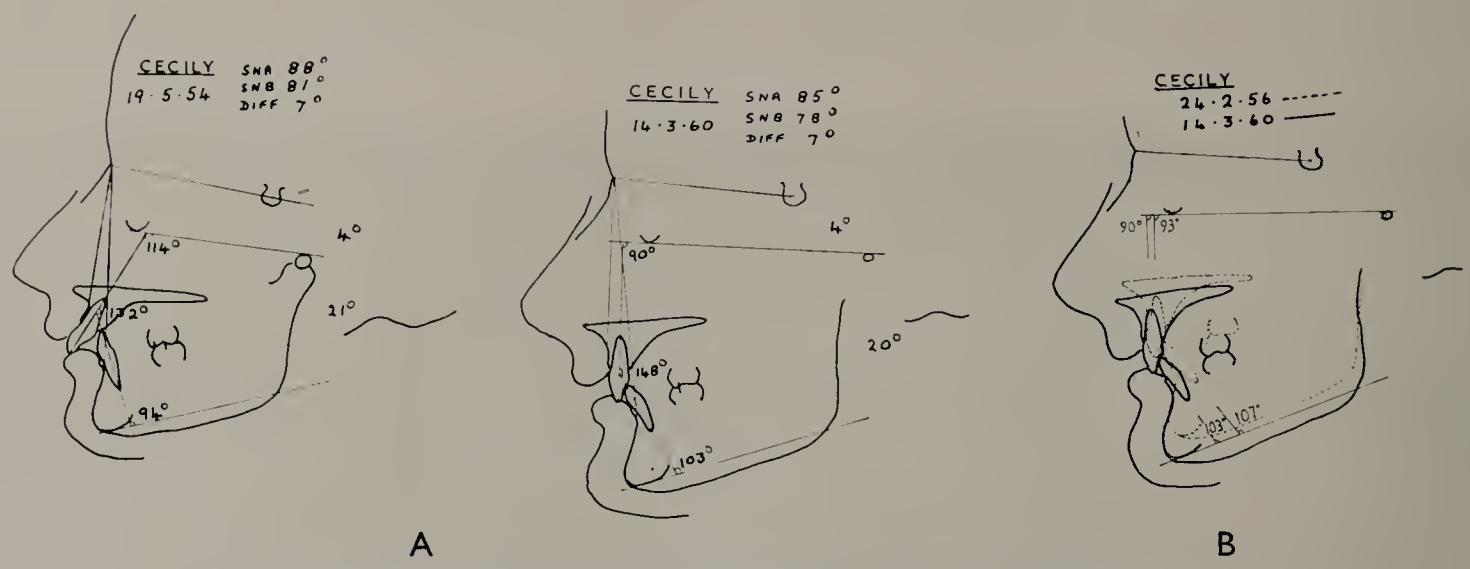

Fig. 2.—Showing the original and subsequent tracings of Cecily (division 1).

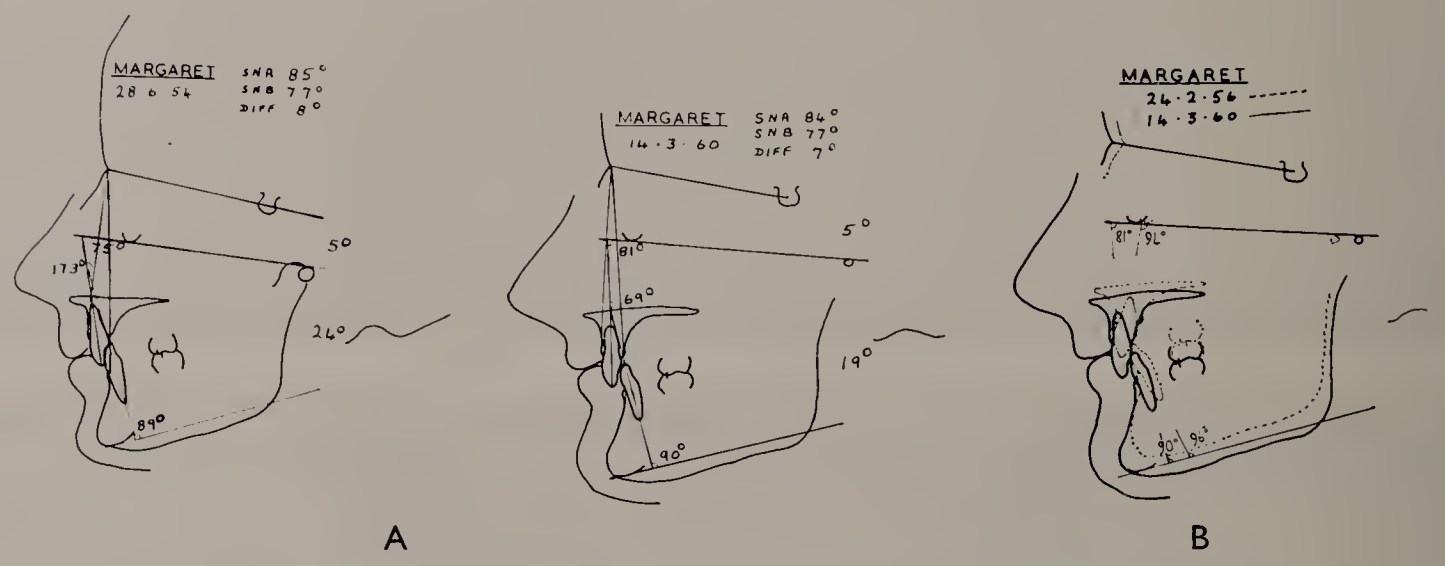

Fig. 3.—Showing the original and subsequent tracings of Margaret (division 2).

In the case of Cecily (division 1) there is marked improvement in her incisor relationship with a reasonable buccal occlusion, although there remains some slight crowding in this region, even though $\frac{5|5}{}$ were extracted. The incisor overjet is now normal, and the deep overbite lessened with the lower incisors stable at 103° to the mandibular plane compared with the original 94°, and with the upper incisors at 90° to the Frankfort plane compared with 114° originally (*Fig.* 2).

The tracings for Feb. 2, 1956, when the bands were removed and a retention appliance inserted, show an interesting comparison with the final tracings. The upper incisors

In the case of Margaret (division 2), the improvement in the incisor relationship was not maintained and all that was really achieved was a relief of the crowding in the upper incisor region, the overbite being the same, or, if anything, a little worse. The lower incisors are now stable at 90° to the mandibular plane which is almost the same as the original of 89°, and the upper incisors are 81° to the Frankfort plane compared with 75° originally (*Fig.* 3). This was due partly to a proclination of the upper incisor crowns and partly to a palatal movement of their roots.

A comparison of the final tracings with those taken at the time of fitting a retention

plate shows that the upper incisors have relapsed from a position of 94° to the present 81°, whilst the lowers have relapsed from 96° to the present 90°; i.e., they were both over-proclined during treatment and then became retroclined again after the appliances were removed. This relapse was only slight during the first year after retention and then increased a great deal more in the succeeding years.

Thus the bodily movement of the roots of the upper incisors through the maxillary alveolar bone in a palatal direction was ultimately successful only by a matter of some 6° (81° to the Frankfort plane compared with the original 75°). In neither case, however, did the lower incisors collapse further lingually than their original position, even though two lower premolars were extracted, because of the support from the remaining posterior teeth which were pulled forward by inter-maxillary traction.

COMMENT

The morphology and treatment of fifty Class II, division 2 malocclusion cases was summarized some years ago by Professor Ballard, and more recently a paper on this subject was given to this Society by Miss Ridley. This single contribution of mine and the experience of many more such cases under treatment support their contention that the improvement of the deep incisor overbite in Class II, division 2 cases is possible only to a very small degree and I personally doubt whether the results obtained with the time-consuming torque action of a Begg or Edgewise arch are in the end any better than those obtained with a plain round arch with third power bends, a Johnson Twin Wire arch, or even a removable appliance used purely for the relief of crowding.

I would like to thank Professor Walther for allowing me the facilities of the Royal Dental Hospital Orthodontic Department for seeing these twins again, and Mr. Holton of the Luton and Dunstable Hospital for taking the final photographs.

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DISCUSSION

Miss D. R. Ridley, opening the discussion, said that it was most interesting to be able to follow the progress of the twins in that way.

The appearance was obviously improved in both cases, but it was interesting that the final overbite should be worse in the case of Margaret, originally Class II, division 2, than in the case of Cecily, originally Class II, division 1.

During the discussion on Mr. Leech's first paper on the twins, in 1955, Professor Ballard implied that the occlusions were identical and all the factors the same in both cases except that, in Cecily, the upper incisor teeth were caught in front of the lower lip, and in Margaret they were behind the lower lip. Had this been the only difference, surely one would expect the final result to be the same, especially as the girls had identical extractions, similar appliance therapy, and the occlusions looked very much alike at the end of active treatment. There had, therefore, to be at least one difference between the two which persisted and had produced the alteration in the end-result.

In the first paper Mr. Leech had mentioned that Cecily had a slight tongue thrust, also that the lower incisors were originally more proclined in Cecily than in Margaret, in spite of Cecily's lower lip contracting directly on to her lower incisors, whereas Margaret's lip pressure was mainly on the upper incisors.

If that tongue thrust had persisted in Cecily, it could explain why her upper and lower incisors were stable with incisal contact, reasonable overbite, and with proclined lower incisors. The thrust was preventing the relapse of incisors into the positions taken up by Margaret's incisors. Mr. Leech had not mentioned the thrust on the present occasion, and she wondered if he could comment on that point.

She also asked Mr. Leech if he had devised a way of measuring palatal movement of incisor apices, as she found that that was almost impossible due to the lack of true fixed points.

It was only by following through in that way that stability of treated cases could be assessed. She was sure that far more was learnt from relapses or failures than from successful results. Many claims had been made for certain types of mechanical therapy, which she was sure would not be substantiated should the cases be followed in the careful way that had been shown.

She congratulated Mr. Leech on his series of papers and thanked him for giving them the benefit of his findings.

Mr. E. K. Breakspear asked how far did Mr. Leech think that the change in proclination of upper and lower incisors over that period of years was due to a normal age maturation?

Mr. J. R. E. Mills said that he would like to know how long the cases were retained and how long it was since the

patients last wore any type of appliance for retention or any other purpose.

Professor G. E. M. Hallett congratulated Mr. Leech on his communication. For a long time he had hoped that they would enter on a period when they would see the long-term fruits of their orthodontic efforts, and he was sure that by studying cases over a long period they would learn more than by mere theorizing. He hoped that Mr. Leech would, indeed, come back with his cases and that the last had not been heard of his "saga". In perhaps another four years' time they would hear about the end-result (even if it meant a complete relapse) and perhaps Mr. Leech would then give a very full paper and analysis together with original radiographs. It was always difficult to interpret radiographs when one had not seen the originals. He noticed that in some of the drawings where the mandibular posterior plane had been produced towards the condyle it ended in a variety of positions and one could not help wondering whether the lateral skull films were not quite true or whether there had been variations in interpretation of the condylar region. He would like to see the serial lateral skull radiographs and the superimpositions done either on the SN line or on the maxillary plane.

Mr. J. H. Hovell said that two points on soft tissue had been raised—tongue thrust by Miss Ridley and maturation by Mr. Mills. He wished to raise another question, on lip morphology. It had struck him that the skeletal patterns of the twins were very similar, but the lip morphology was different. In the Class II, division 1 case the incisors were more proclined, the lips were parted at rest, whereas in the original Class II, division 2 case the lips were sealed. Perhaps Professor Ballard's original observations had not been quite correct. Unfortunately Professor Ballard was not present to hear that, and in actual fact the reason for the original difference in the occlusions was, possibly, tongue thrust or, as he himself thought, a difference in lip morphology.

Mr. Leech, in reply, said that on the question of the soft-tissue behaviour patterns and whether the tongue thrust in the Class II, division 1 persisted, as far as he could judge, originally, the lips were equally competent, but that, in the case of the Class II, division 1 girl, the upper incisors were protruding between them—they were potentially competent. They both, on swallowing, had a certain amount of contraction of the lips. In the case of the Class II, division 1, the lower lip contracted underneath the upper incisors, whereas in the Class II, division 2 the contraction was still there, but with the lower lip over the upper incisors. The only real difference he could see between them, as far as the soft tissues were concerned, was that Cecily, the Class II, division 1, had a tongue thrust, but it was very, very slight; in fact, at the end of the treatment when he tried to see if she still had a tongue thrust, he could not detect one. He was not suggesting he had cured it, but it was so slight to begin with that he would not attach a great deal of importance to it.

The Class II, division 2 girl had a different disposition altogether. She was a much more apprehensive type. He hesitated to use the word "hypertonic" lips, but that was the feeling he had—that the lips were more difficult to part in the Class II, division 2 girl than in the Class II, division 1 case.

He agreed that it was interesting that, in the final tracings, the whole of the dentition in the Class II, division 2 girl was set farther back than it was with the Class II, division 1 case, but as to the exact explanation of that, he did not think he could offer a better explanation than anyone else.

With regard to the apical root movement through the alveolar bone, he had not shown a slide of that again as he had done in the previous paper when it was obvious to him that the roots of the upper central incisors were originally up against the labial plate of alveolar bone, whereas at the end of the active treatment they were certainly more up against the palatal plate of the bone. Looking at the X-rays taken at the end of the period, the final tracings, three years and three months after the end of all treatment, showed that these incisor roots had relapsed forwards again, but not quite so much. That was a visual observation; he had no actual measurements except from their relationship to the Frankfort plane.

Whether there had been any maturation of the soft tissues causing a proclination of the incisors, he could not answer any better than Mr. Breakspear could. The old subject of maturation had been discussed before, and he thought it was a very tricky subject. He did not think the answer to it was known.

With regard to Mr. Mills's question, the active treatment was about fifteen months with the multi-band appliances, and they were retained for nine months after that. The final results were shown three years and three months after the retention appliances were removed. It may have been that they were not retained sufficiently long and that Class II, division 2 cases required a greater period of retention.

He was sorry to hear Professor Hallett ask him to present further observations in the future. Certainly, if the girls produced children of their own who were twins, he would present another paper to the Society!

A METHOD OF TREATING CLASS II, DIV. 1 CASES WITHOUT USING THE LOWER ARCH FOR ANCHORAGE OR TRACTION

By **D. A. PLINT**, B.D.S. (Rand), F.D.S. R.C.S. (Eng.), D.Orth. (Eng.)
Royal Dental Hospital of London

In a large number of Class II, division 1 cases it is not possible to use the lower arch for anchorage or traction without resorting to extractions in this arch.

Extractions in the lower arch mesial to, and including, the lower first molars usually means that a lower multiband appliance must be employed to ensure that the lower arch can be properly utilized for Class II traction, and also that residual spacing may be closed.

However, there are a number of cases in which, for various reasons, the operator does not wish to utilize the lower arch for anchorage; these cases fall into the following groups:—

1. Cases where there is neither lower arch crowding nor spacing, and soft-tissue morphology contra-indicates any proclination of the lower labial segment during treatment.

2. Cases where there is a minimal degree of lower incisor imbrication, and treatment is simplified by maintaining an intact lower arch. In some of these cases extraction of the lower second molars may prevent deterioration of the incisor imbrication. (The third molars should be present and well formed.) This increase in incisor imbrication, which is often seen in the adolescent, may be due to the developing second and third molars, or alternatively it may be the result of the straightening of the profile. This change, as described by Björk (1957), takes place in the bite during the growth period he investigated (namely 12–22 years), and the axes of the incisors in both jaws become more vertical. It is possible that this uprighting of the incisors, and increasing imbrication in the adolescent, may be due to a conscious effort on the part of rather self-conscious young adults to keep their lips together. Later this conscious effort may become reflex in nature.

It is interesting to note that the extraction of the lower second molars gives no assurance that the third molars will erupt in good position. Smith (1957), in a discussion of the eruption of third molars following extraction of second molars, states that in the cases investigated the upper third molars erupted, almost without exception, into good positions. The lower third molars exhibited a wider range of final position. The majority erupted into occlusion, but were tilted in varying degrees.

3. Cases where there has been early loss of deciduous molars and, owing to tooth–tissue disproportion, there has been forward movement of the lower first molars, resulting in blocking out, or partial blocking out, of the second premolars; here it is possible and indeed advisable to extract in the lower arch. The extraction of the second permanent molars will often allow the second premolar to force its way into the arch without deterioration in the incisor region. In some cases where the first molars and first premolars are in contact, and the second premolar lingually placed, this latter tooth is the extraction of choice. If the second premolar is vertically positioned, the extraction of the first premolar may be preferred, possibly with the fitting of a space-maintainer. Where premolars are extracted, there is no attempt to treat any collapse of the lower labial segment.

4. Cases where, because of certain circumstances, crowding in the lower arch is accepted: These include those cases where the multiband technique is not practicable, or others where it is the intention of the operator to extract a tooth or teeth later, when opportune, e.g., the extraction of a lower incisor when it is almost completely excluded from the arch. This type of extraction is often best delayed until the patient is 16–20 years of age.

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5. Finally, there will be some cases where (because of gross crowding in the lower arch) the lower arch is treated by the multiband technique, but it is inadvisable to make use of this arch for anchorage or traction purposes.

In these groups, then, in most cases the upper arch only is treated by means of appliance therapy, and therefore a simple and safe method of anchorage and traction is required. The following methods have been evolved for use in cases where the aetiology indicated disproportion between size of teeth and size of dental arches, and where there has been a forward shift of upper buccal segments of about one unit or more. The method under discussion is selective, for in some cases where the degree of disproportion is slight, extractions mesial to the first molar are not always indicated, and if they are, it is often desirable that the buccal segments distal to the extractions move forward during treatment to assist in space closure. It is as well to make it clear that the methods and appliances to be described are not intended in any way to replace or supersede other methods. In fact it is important to choose the best appliance or appliances for each individual case. It is not advisable to belong to a fixed or removable appliance school as there is no such thing as a universal appliance that will treat every type of case (Walther, 1960).

Although the methods to be described may be applied where other teeth have been removed, in order to simplify the description a treatment plan based on the extraction of the upper first premolars will only be considered. This will embrace the extraction of upper first premolars, retraction of the upper canines, depression of the lower incisors, and alinement of the upper incisors. Ideally this is carried out after the replacement of all deciduous teeth.

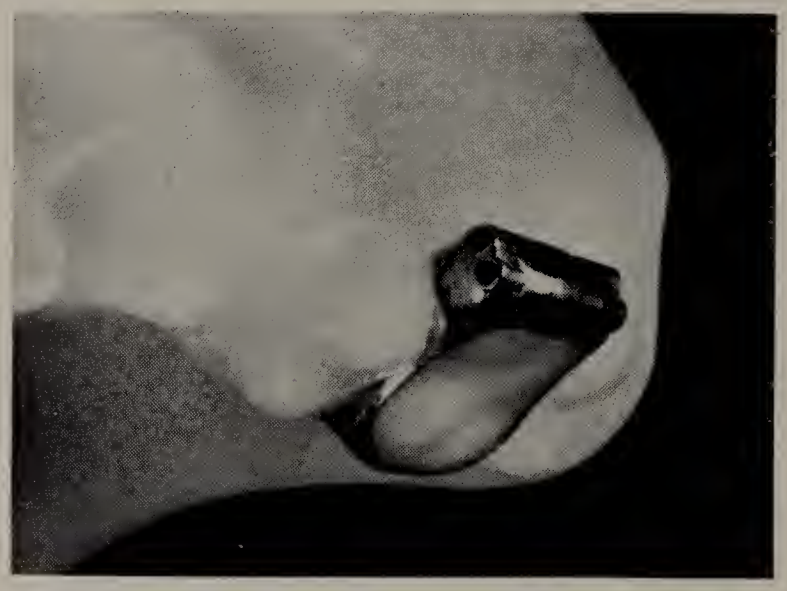

Fig. 1.—Molar band showing double tubes soldered to buccal surface.

Fig. 2.—*Note* $\frac{3}{4}$ clasps gingivally positioned to buccal tubes, and close-fitting labial bow.

APPLIANCE FOR SIMPLE RETRACTION OF CANINES

Bands are made for the upper first molars and double tubes are soldered and/or welded horizontally to the buccal surfaces of the bands (*Fig.* 1). Although the choice of the diameter of the tubing and whether round or rectangular tubing is used depends on the individual operator, it is suggested that one tube be of 0·040 in. (1·0 mm.) diameter and the other 0·036 in. (0·9 mm.), the former being placed gingivally. Double tubing, ready prepared to these specifications, may be obtained from the Rocky Mountain Metal Products Co. If manufactured tubing is not available, it is quite a simple matter to tape, weld, and solder on two lengths of tubing of different diameters to bands—the wider diameter tubing always being placed gingivally.

After the band has been cemented, a plaster model is prepared from an alginate impression for constructing the following appliance (*Fig.* 2):—

Clasps embracing the distal and buccal sides of the molars, gingivally to the tubes, are fabricated from 0·7-mm. hard wire; to prevent trauma from the free ends, they are turned back on themselves and welded. Palatal

springs prepared from 0·5-mm. hard wire are boxed in on the fitting surface of the plate; they are equipped with guide wires placed palatally to prevent distortion of the spring on removal of the plate for cleaning (*Fig.* 3). (It is found that palatal springs are liable to be bent palatally, causing trauma to the soft tissue and dislodgement of the plate.) A plain

Fig. 3.—Shows clasps, labial bow, and palatal finger springs. *Note* boxing and guard wire.

labial bow is prepared to engage only the incisors, which it fits closely near the incisal edge. By preventing the incisors from tipping, so that they must move bodily if the buccal segments move forward, the bow reinforces the anchorage and adds stability to the plate. Where it is indicated, an anterior bite-plane may be added to depress the lower incisors. As there is some doubt regarding the efficacy of this method for the adult (Broadway, 1957), its use may be limited to the developing dentition.

The third component of this appliance is the headgear or cervical anchorage, which is worn only at night (*Fig.* 4). A labial arch is formed in the mouth of 1·0-mm. hard wire, so that it clears the upper incisors by 0·5–1·0 cm., and engages in the 1·0-mm. tubes. The arch is marked in the midline of the face and mesially to the buccal tubes. To this arch is soldered, at the midline, an extra-oral arch of 1·5 mm. diameter, which is bent to conform to the outline of the cheeks with a clearance of about 1 cm. The ends of the extra-oral arch are turned back into loops at a point where they pass below the outer canthus of the eye, and will be used to engage the cervical traction elastic. It is important that this arch should be symmetrical in length to provide equal force on the molars (Haack, 1958). A variety of neckbands and elastics is suitable, but that supplied by the Orthoband Company Inc., St. Louis, is recommended. In order to keep the labial arch clear of the incisors when traction is applied, stops are added at the

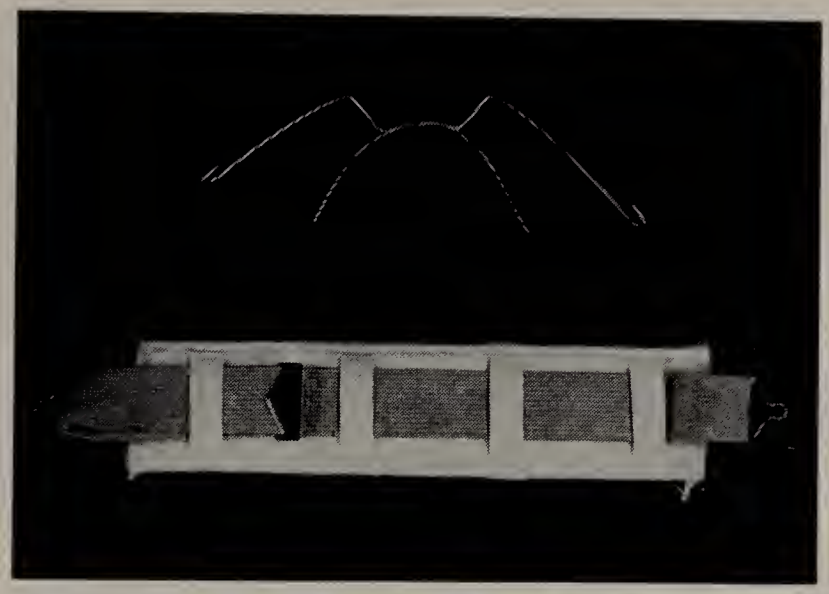

Fig. 4.—Headgear or cervical anchorage apparatus. Intra- and extra-oral arch wires and neckband.

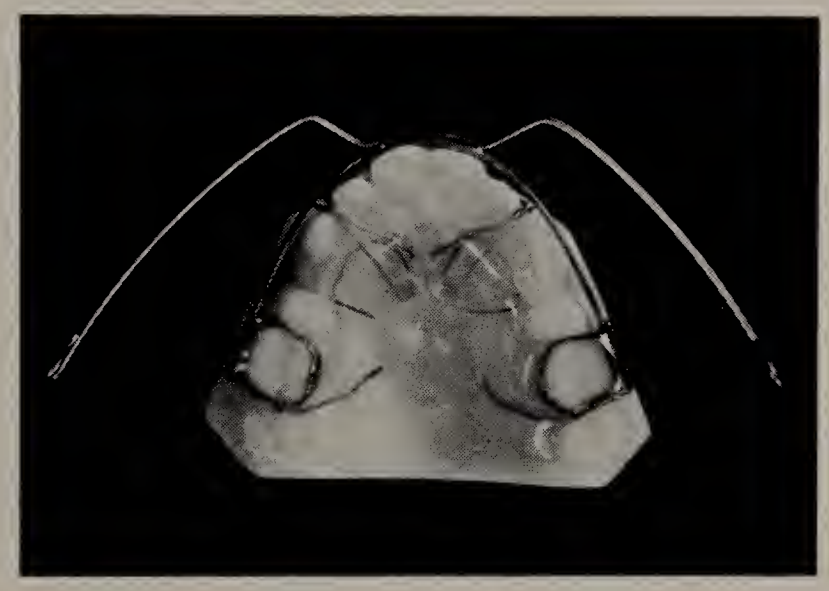

Fig. 5.—Cervical anchorage apparatus in position.

marks previously made mesially to the buccal tubes. Stops may be of the friction type, and these have the advantage of easy adjustment, and they also do not interfere with the temper of the wire, as is often the case where welded or soldered stops are used (*Fig.* 5).

It is suggested that the plate be fitted first, without activation of the springs. At the next visit the cervical traction gear should be added, and instructions given in the method of assembly. If there has been no discomfort, activation of the canine springs may be

started. Some slight soreness of the molars, however, is to be expected during the first few days. If this persists, the elastic band may be slackened, as it is probable that the cervical gear is accomplishing more than reinforcement of the anchorage.

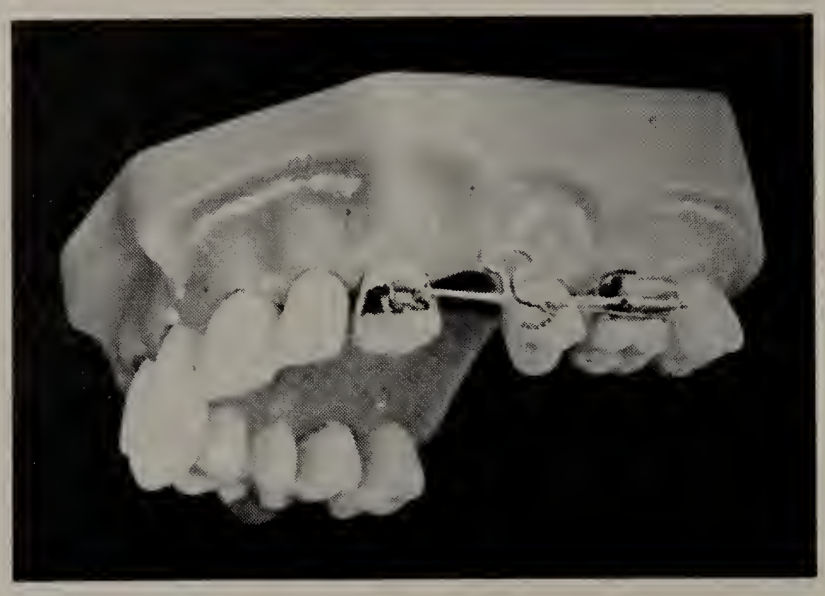

Fig. 6.—Shows canine, molar bands, and sectional arch in position.

APPLIANCES FOR BODILY RETRACTION OF CANINES

In some cases the axial inclination of the upper canines is such that bodily retraction is necessary to produce an æsthetically acceptable result. For these cases, where the canines are not inclined mesially, a tipping movement is contra-indicated.

Bands are made for the upper canines and first molars (*Fig.* 6); to the former are attached edgewise brackets. To the molar bands are welded double tubes which may be two round tubes or one round tube for the cervical attachment, and one edgewise tube. The routine double tube has been found quite satisfactory. Two sectional arches are bent to incorporate Bull loops and a bracket or coil for tie-back ligatures. A plate is constructed with molar clasps, a plain labial bow, and flat anterior bite-plane, as previously described. The headgear also is similar, but it is important that the intra-oral arch should be clear of the Bull loops.

APPLIANCE FOR RETRACTING INCISORS WHICH ARE IN GOOD ALINEMENT

For cases where there are no rotations or overlapping of the incisors, the plate is modified in the following way: The canine springs are replaced by stops (spurs) of 0·6-mm. hard wire and the plain labial bow by a 0·7-mm. bow extending distally to the canines with U-loops or reverse retraction loops. These modifications can be hastened by securing the wires with cold cure acrylic on a model prepared from a composition impression. The headgear remains unaltered. The plate is trimmed away palatally to the upper incisors at each visit, in order to provide a bite-plane engaging the lower incisors for as long as possible. When trimming the plate it is important to cut away not only the section of the plate bearing on the palatal surfaces of the incisor crowns, but also that bearing on the mucosa over the roots of the upper incisors. This reduces bunching of the palatal mucosa often associated with this phase of the treatment, and also may prevent unnecessary tipping of the incisors, which may occur by careless trimming of the plate. As an alternative, a high labial bow with an apron spring may be used to retract the incisors; this, however, has the disadvantage of liability to fracture of the fine 0·35-mm. spring, and of being (in some cases) insufficiently powerful to overcome the lip and tongue action. Some operators prefer to "saddle" the plate palatal to the upper incisors before retracting these teeth, and this can always be done in cases where the overbite was incomplete or reduced from the outset, or in cases where a lower fixed appliance is used to open the bite. Once the desired result has been achieved with the low labial bow, this plate may be used as a retention appliance, whether or not headgear is worn. Alternatively, by modifying the headgear, by adding two small hooks in the premolar area and stretching Paul's tubing between the hooks, the incisors can be retained without a plate.

APPLIANCE FOR RETRACTING INCISORS WHICH ARE IMBRICATED OR ROTATED

The plate is modified to retain the canines in correct position, the labial bow removed, and the plate lightly trimmed palatally. Bands are made for the upper incisors, and alining arches used until the incisors are ready for retraction. The headgear is continued unaltered. The incisors may be retracted with an arch

incorporating Bull loops, or traction coils with intramaxillary elastics. As before, the plate is eased palatally until the upper incisors are in the required position.

DISCUSSION

The methods described above are certainly not original in their entirety. They are merely a combination of methods previously used to achieve certain tooth movements and to obtain stable anchorage. The question as to whether upper molars should be banded and double or single tubes employed, as a routine, depends on the individual operator and the case in point. Some operators have found that tubes on the horizontal bridges of Adams clasps are a useful method for supporting extra-oral anchorage.

It has been my experience that when molar bands are used the extra-oral anchorage is more stable, and thus greater patient co-operation is achieved. If sectional arches are to be used in order to move the canines bodily, then banding is essential. Where bite opening is indicated, the anterior bite-plane is an important part of the procedure, and works well during the stage of the developing dentition. D. Smith and other operators at the Royal Dental Hospital, London, have used a similar method where they band the upper canines and first molars and use a bite-plate to open the bite and to afford additional anchorage. The canines are retracted by compression coils on a round arch mesial to the canines.

SUMMARY

A method of treating Class II, division 1 cases without using the lower arch for anchorage or traction purposes has been described. This means that the method is selective in that the lower arch is not usually treated, and the degree of disproportion is such that forward shift of the upper buccal segments during treatment is undesirable. The basic appliance consists of molar bands with double buccal tubes, a bite-plate incorporating a plain labial bow on the incisors, three-quarter clasps placed distally on the first molars, positioned gingivally to the buccal tubes on the bands, and palatal springs to retract the canines. Where bodily movement of the canines is required, sectional arches are used to retract them in place of the palatal springs. A form of extra-oral anchorage is used engaging in the buccal tubes on the molars, to prevent forward shift of the upper buccal segments during treatment.

Acknowledgements.—I wish to express my thanks to a colleague, Dr. B. E. Fainsinger, who has been an able ally in the formulation and testing of this method of treatment of Class II, division 1 cases.

I also want to thank Mr. Taylor for the photographs and slides, and Mr. McBride for some of the models and the plate shown. My thanks too go to other members of the staff of the Royal Dental Hospital for their help in preparing this short paper.

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DISCUSSION

Professor D. P. Walther said he was very interested in the problem of Class II, division 1 cases in which the lower arch must not be used for anchorage. In the vast majority of cases it did not matter very much if the upper five and six came forward slightly; if, however, they should come forward too far, it was extremely difficult to move them back again. He therefore tended to use extra-oral anchorage rather more than most people; in fact, he had been accused of being the sort of person who wore belt and braces, and perhaps Mr. Plint would be tarred with the same brush after his paper.

The appliance appealed to him greatly for use in certain cases, particularly those in which the upper canines were distally inclined and it was desired to move back their apices.

There were one or two questions he wished to ask. What was the advantage of the appliance over the usual

entirely removable appliance plus extra-oral traction in the straightforward case, apart from the possible increased stability?

His experience was that if Adams clasps were properly made, the retention was extremely good.

Did the patients tend to dislodge the bands when they took the plate out? Also, did Mr. Plint find that the extra guard wires, plus the boxing-in, led to much extra stagnation? Perhaps he was being rather stupid, but were the two tubes on the upper sixes really necessary except when retracting the upper canines with a rectangular arch? Why must they be of different diameter, and why the larger placed gingivally? Had Mr. Plint ever used the Higley principle of combining the fixed and removable appliances to help anchorage? For example, instead of clasping the upper sixes, had he used locks on the palatal side of the upper six bands? He was very interested in the palliative approach to the mandibular arch. That could be a very great help in reducing treatment.

Mr. J. R. E. Mills felt that Mr. Plint had no cause to apologize for giving a paper on a technical matter; appliances formed an essential part of orthodontics, without which diagnostic skill was useless.

He was one of the people who had accused Professor Walther of wearing belt and braces! He felt that there was a modern tendency, to which Mr. Plint was contributing, to make removable appliances overcomplicated. A well-designed removable appliance had a great deal of inherent stability, taking its anchorage not only from the obvious anchor teeth, but also from its contact with the palate and anterior teeth. There was also another factor in anchorage which was often overlooked; it was easy to move buccal teeth mesially, but much more difficult to move them directly anteriorly, since this took them obliquely towards the outer plate of bone. A removable appliance therefore received much anchorage by maintaining the distance between the buccal teeth of the opposite sides, across the palate.

He felt that any removable appliance should be as simple as possible. It should consist of its acrylic base, with the minimum number of clasps, springs to move the teeth, and nothing else. The addition of a labial bow, or extra-oral anchorage, made the appliance difficult to wear, and gave a false sense of security. Their use should be confined to exceptional cases. It was, however, most important to check the position of the buccal segments at every visit.

Mr. E. S. Broadway wanted to touch on the fringe of Mr. Plint's paper and ask whether he had, in fact, followed up any cases where the lower arch had been treated by removal of the second molars over a long period. He had recently had an opportunity of seeing some patients who had had the second molars removed to relieve suspected impaction of third molars, and the results were very disappointing. Over a period of about fifteen years, their molars had erupted; most of them had come into reasonable position, but all had very deep pockets round them. Could Mr. Plint comment on that?

Mr. K. E. Pringle referred to the appliance and said he was not quite sure whether or not he needed to use anything quite so elaborate. What Mr. Plint was getting at was the fact that people very often did pull forwards the buccal segments while treating the Class II, division 1 case. They did not always, as Mr. Mills suggested, keep the plate against all the teeth. The anchorage was very often lost. He was talking about practical things that one saw every day. Buccal segments were pulled forwards.

He thought that what happened was that people over-tightened appliances and, in that way, overstressed the possibilities of movement. Movement of the canines or the incisors did not take place, but the cheek teeth were brought forward.

Mr. S. G. McCallin said that, as many people would know, he was particularly interested in extra-oral traction; he had used it extensively for about four years and he was interested in Mr. Broadway's problem; but he thought the pocketing that was associated with a mesially inclined lower third molar tended to disappear if the third molar was uprighted. That was something they would have to be prepared to do when lower second molars were removed. They had not completed their obligations to the patient until they saw that the third molar was properly in the mouth and properly uprighted.

Listening to Mr. Mills, and watching the pictures on the screen, he had found with extra-oral anchorage that, if a patient had to cope with placing more than one thing, he would find the whole thing too much. If they had got to bring their parents or brothers and sisters into the placement of the apparatus each night, it was seldom going to be successfully tolerated. His own feeling was that to ask the patient to insert a removable appliance and add the extra-oral apparatus was putting quite a burden on his enthusiasm. It was an interesting idea, and new to him, but he wondered whether Mr. Plint had found that patients found it difficult to get going with his apparatus?

Mr. Plint had discussed distal movement of canines, but not distal movement of buccal teeth; the apparatus, as he understood it was purely for the reinforcement of anchorage. Had he any experience with distal movement of buccal teeth?

There was no doubt that extra-oral traction for tooth movement and stabilization was one of the really worthwhile additions to their armamentarium in the last five or six years. All over the world that particular type of tooth movement was being employed, and those who had used it fairly extensively felt inclined to use it more and more. He was therefore very pleased that Mr. Plint had come along and told them more about it.

Mr. D. F. Glass asked about the problem of mesial movement of buccal segments. Unlike Mr. Pringle, he had some cases in which the buccal segments had moved forward. He considered that they were very difficult to move back once they had moved forward. He had noticed that this did not occur during the retraction of canines. He had also always found that the segments moved forward during the retraction of incisors when the lower lip was very powerfully postured inside the upper incisors. The upper incisors were being pulled back against the lower lip, and the combined pressure of lower lip and incisors was too great for the molar anchorage, with the resulting mesial movement of the posterior teeth.

Mr. E. K. Breakspear wanted to take up the point of extracting the lower sevens to prevent imbrication of the lower incisors. He was all in favour of removing the lower sevens to prevent imbrication of the eights when necessary, but felt that the eights were often blamed for effects which were not really their fault at all. For example, he had seen cases where the lower eights were absent, but incisor imbrication had occurred. Might not the late incisor imbrication be due to the profile changes which had been mentioned, by which the pressure of the

lips became relatively greater in relation to the tongue at a later age? That might have the effect of increasing the incisor overlap and producing imbrication from that cause rather than from pressure in the third molar region.

Miss L. M. Clinch said that she wished to make two points. One was in connexion with the appliance. As Mr. Pringle had said, people were apt to tighten them too much and possibly cause movements they did not want. Over the years, she had found it very much better to see patients at longer intervals between their visits than she used to. The patient came whether the appliance needed adjusting or not and one adjusted it just because the patient was there. Provided an appliance was working and comfortable, the longer intervals that could be left, within reason, the better.

The second point was nothing to do with appliances but was apropos of a remark Mr. Plint made at the beginning of his paper. He said that there were two categories of patients in which imbrication of the lower incisors was acceptable. As far as she was concerned, they must be awfully big categories. One thing she would not guarantee to anyone was to straighten lower incisors and keep them stable. It was the most unstable part of the mouth. It was easy enough to get the teeth into alinement, but difficult to say whether they were going to stay in alinement after the appliances were removed. Would Mr. Plint agree?

Mr. Plint, in reply, thanked the opener, Professor Walther. Professor Walther had asked whether the tubes of the Adams clasp might not in some cases be just as stable, and answered the question himself when he said "if the Adams clasps are well made". If the Adams clasps were well made, they would support extra-oral traction or anchorage. If not, the patient's plate would not only be in the pocket during school hours, but under the pillow during sleeping hours. The main thing was, if Adams clasps were to be used, they had to be well made.

With regard to bands coming off, his bands always came off, the upper ones not quite as frequently as the lower. Whether that was due to the fact that he got a better cementing bond in the upper, he did not know. He did not, however, think there would be a lot of trouble if the child was trained to get his fingernail under the three-quarter clasps and pull them outwards and downwards.

Regarding stagnation in the boxes, the guard did tend to increase the stagnation; however, it depended on the oral hygiene of the child. He usually told a child, if it had its midday meal at school, to take the plate out and rinse it under the tap, hoping this would help to keep the boxes clean.

About double tubes, he had mentioned that it was a matter of choice whether round or rectangular tubes were used. In fact, when he had first prepared the paper, which was some time ago, he was using double tubes as a routine. Later he used single tubes more often. However, the double tubes supplied by the Rocky Mountain Company were easy to solder on to bands, and they had the advantage that they could be removed and used again. If your technician did that work for you, it took no time to put on the extra tube, which might be found useful at a later stage in the treatment.

He had not tried the Higley principle, but it might be a good idea, whether or not one used extra-oral anchorage. Improved anchorage might be gained by using the vertical tubes only.

He hated to cross swords with Mr. Mills. All he knew was that he had trouble with his cases and with the students over their cases, usually due to anchorage. He found many Class I cases were turned into Class II, division 1 cases because they had not worried about the anchorage during the retraction of the canines. Whether that was unique to the type of patient they got at the Royal, he did not know, but he found that anchorage was stressed because they had a reason to stress it. In many cases referred in from outside (cases where teeth had been extracted), it was because anchorage had not been fully made use of that space had been lost. If there was plenty of room, one did not have to worry, but in cases with limited space to play with one had to be careful to ensure that anchor teeth did not move. The method had the advantage that, if you had banded the $\underline{6|6}$, at any time during the course of treatment you could start extra-oral anchorage.

He agreed with Mr. Mills about the close-fitting labial bow; it did not allow for spacing of the upper incisors. That was a disadvantage. What he did, when the $\underline{3|3}$ were almost fully retracted, was to cut off the labial bow and let the laterals drift distally.

On the question of extraction of the lower second molars, Mr. Smith had recorded some cases and he was not able to forecast the ultimate position of the third molars. He himself had not enough experience to give a valid opinion on it. In some cases at the Royal third molars had not erupted in good position, there had been other cases where spacing had occurred, with food traps between the first molar and second premolar; this they had certainly not anticipated.

Mr. McCallin had perhaps partly answered the question in suggesting that the third molars might require repositioning, and they might see more and more of this type of treatment as they tended to take out more and more second molars. He himself did it to make the treatment simpler, and thus avoid the fitting of a lower multiband in many cases. That was why one tended to extract distal to the lower first molar.

Regarding retraction of canines, Mr. Glass found that buccal segments did not come forward during this phase of treatment; it occurred, however, when he was taking back his upper incisors. He was himself sure that one saw it in Class I cases where there was a normal incisor overjet at the start of treatment; everyone had seen cases where, after the canines had been positioned, there was an overjet; hence the routine reinforcing of anchorage with labial bow.

In reply to Mr. Breakspear, he said he could not add anything more to the comments regarding the cause of incisor imbrication in respect of the straightening of the profile (as described by Björk), and "maturation" of the soft tissues and their possible influence on the incisors.

He was interested in Miss Clinch's remarks about the adjusting of appliances and agreed that some of us tended to see our patients and adjust appliances too often.

With regard to the question of the types of incisor imbrication one could accept, there were certain cases where they decided that because the lower arch appeared to be reasonable when first seen, they could accept it. He appreciated that some of those would deteriorate, whatever they did.

Miss Clinch thanked Mr. Plint and Professor Walther for giving them such an entertaining afternoon.

VARIATIONS IN THE DEVELOPMENTAL POSITION OF UNERUPTED PREMOLARS

By **J. S. ROSE**, B.D.S., F.D.S., D.Orth. R.C.S.
Senior Lecturer, Orthodontic Department, London Hospital Dental School

In 1958 I was privileged to read a paper before this Society on "Atypical Paths of Eruption: Some Causes and Effects". During the discussion Mr. Walpole Day asked about the normal path of eruption of premolars in comparison to the abnormal. My answer was somewhat evasive and, though I still do not know enough about normal paths of eruption, I began to look at the different positions in which premolars are found when we radiograph our patients. Whilst doing this, I was impressed by the number of variations, although certain patterns did appear to be repeated.

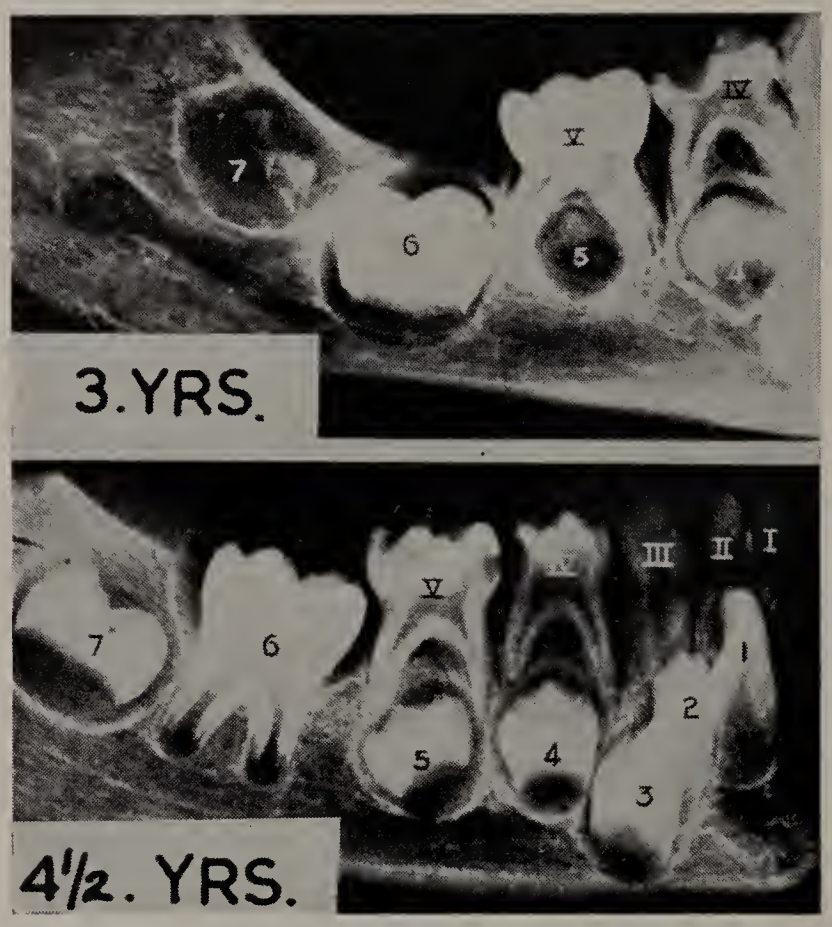
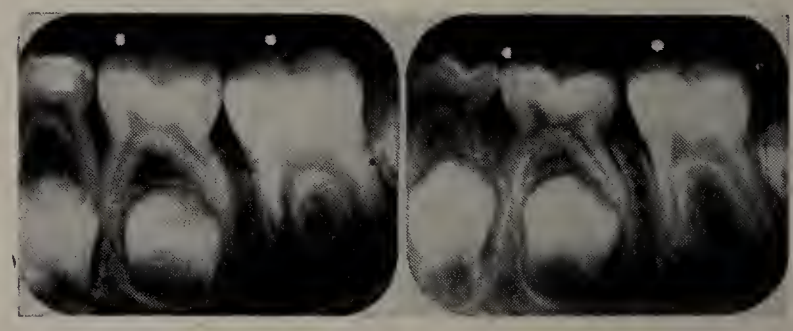


Fig. 1.—Developing premolars at 3 years and $4\frac{1}{2}$ years of age.

The initial problem was to find a method of assessing the position of the premolar, and the simplest way seemed to be to relate the position of the deciduous molar to that of its successor. This, of course, only gives a relative positional relationship, but it is sufficient for the purposes of this paper because no measurements are being used and no direct comparisons are being made, except in the most general manner.

The second problem was to examine the radiographic technique. It is well known that radiographs can give a false picture of what is happening and that the variation of the angle from which a film is taken can cause a false interpretation of what is actually occurring.



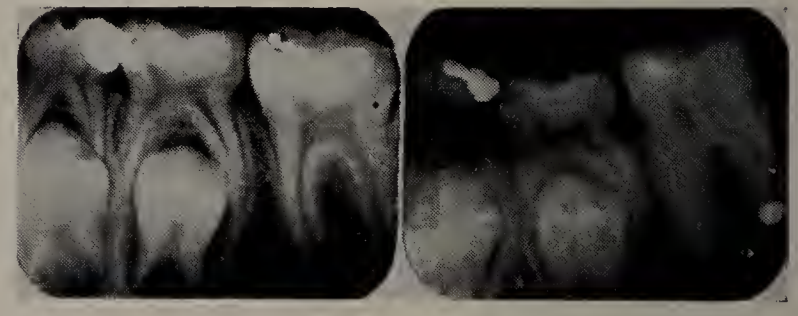


Fig. 2.—Premolars developing between the apices of the deciduous molars at different ages. *Note* the variations in the angle of bifurcation of the primary teeth and the differing shapes of the premolar crowns.

I therefore conducted the simple experiment of X-raying a dried skull, containing a mixed dentition, from various angles. Both intra- and extra-oral techniques were used. The position of the skull was fixed on a 20° angle board, and the tube was moved through a range of 10° beyond the normal angulation, first in a mesial and distal direction, and then in a superior and inferior direction. Altogether five exposures were made with the extra-oral

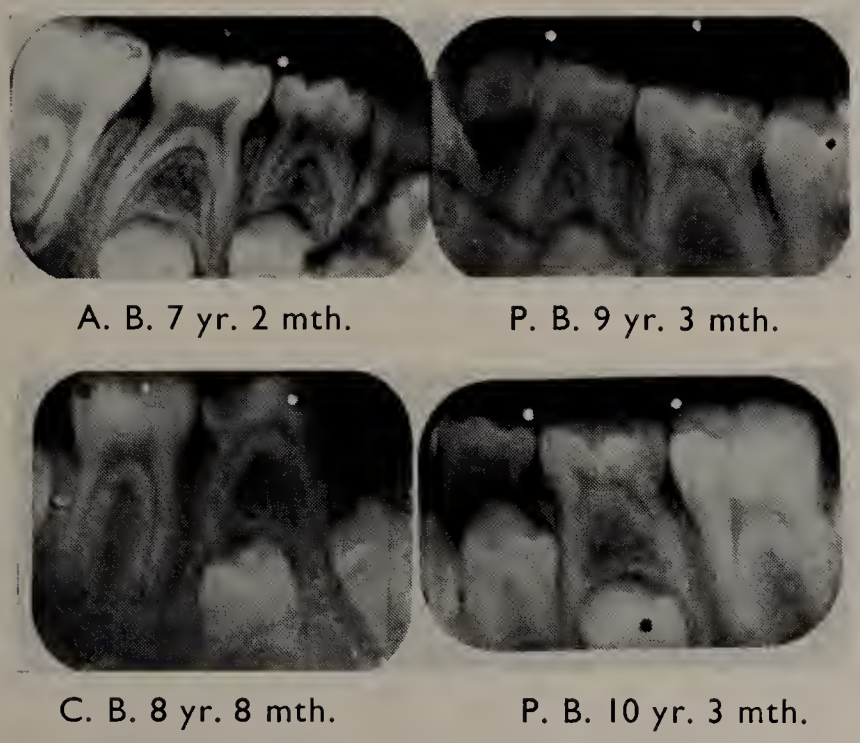
Given at the Country Meeting held at Bournemouth on May 5, 1961.

technique (one normal and four deviations), and a further five with the intra-oral method. This experiment was more fully reported in a paper given to the European Orthodontic Society in 1960.

The results of the experiment showed that it was possible to alter the apparent relative positions of the premolars and deciduous teeth both in a vertical and mesio-distal direction, but the variations were much less marked in the intra-oral X-rays.

It was therefore thought to be reasonable to embark on the investigation using an intra-oral technique, although this would sometimes mean that the whole of the developing premolar would not be seen. However, the X-ray technique is still not precise, and the findings can be open to misinterpretation unless the limitations are appreciated.

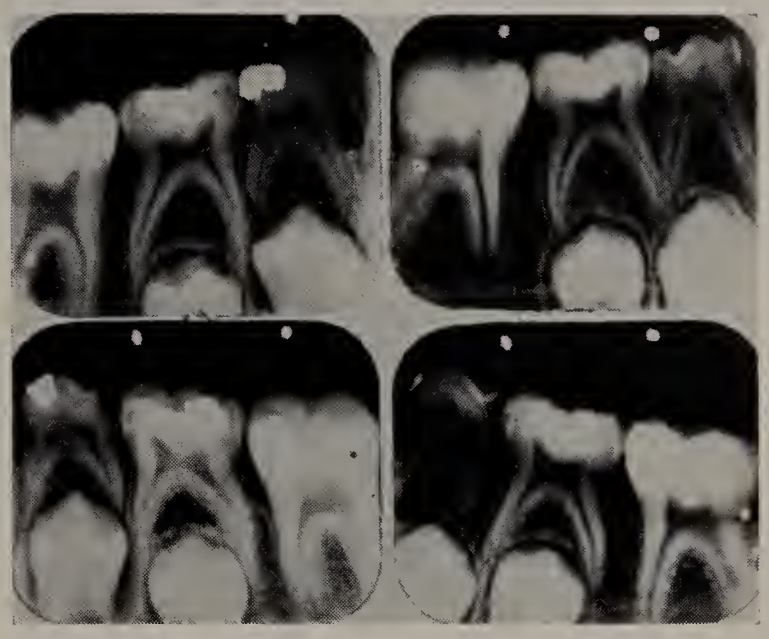
Towards the end of the fifth month of intra-uterine life the premolars begin to develop on the lingual and occlusal aspects of the deciduous molars. By the time these latter have erupted the premolars are found between the roots of their predecessors, typically just below the bifurcation. But, according to Scott and Symons (1961), by 6 years of age they lie at a deeper level in the jaws relative to the deciduous teeth and beneath the apices



A. B. 7 yr. 2 mth. P. B. 9 yr. 3 mth.

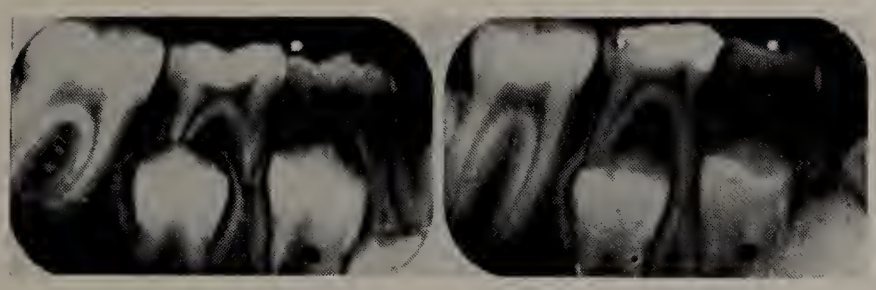
C. B. 8 yr. 8 mth. P. B. 10 yr. 3 mth.

Fig. 3.—Relatively low positions of the premolars. The upper-right picture suggests a missing $\overline{|5}$, but an X-ray taken a year later shows $\overline{|5}$ developing.

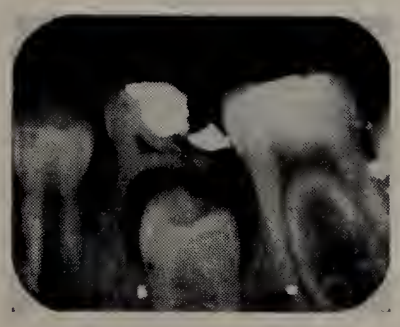


P. J. 8 yr. 6 mth. R. W. 7 yr. 8 mth.

Fig. 4.—Different developmental positions of premolars on opposite sides of the mouths of two patients.

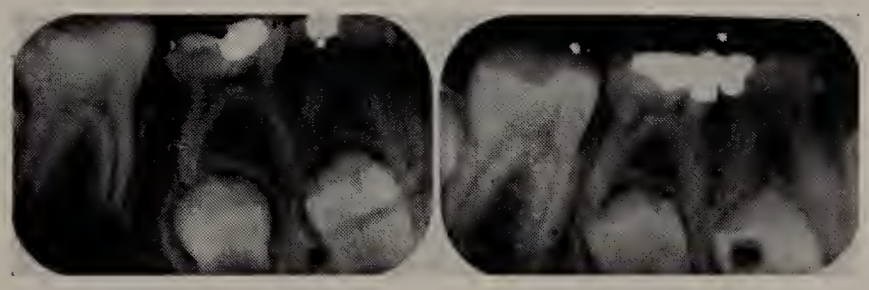


N. C. 7 yr. 10 mth. L. S. 8 yr. 4 mth.

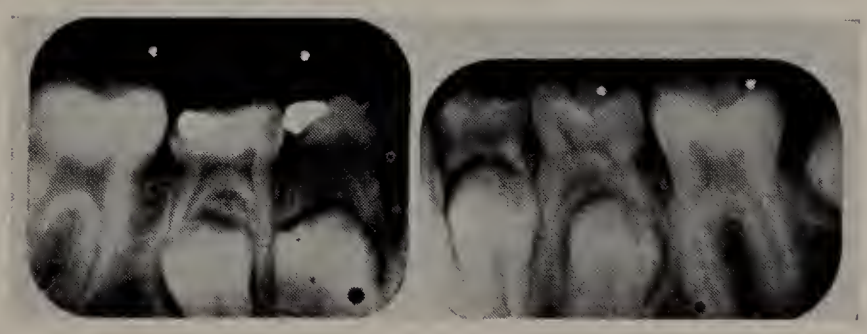


J. A. 10 yr. 10 mth.

Fig. 5.—Premolars developing vertically beneath the distal roots of the second deciduous molars.



F. H. 7 yr. 5 mth. J. M. 8 yr. 6 mth.

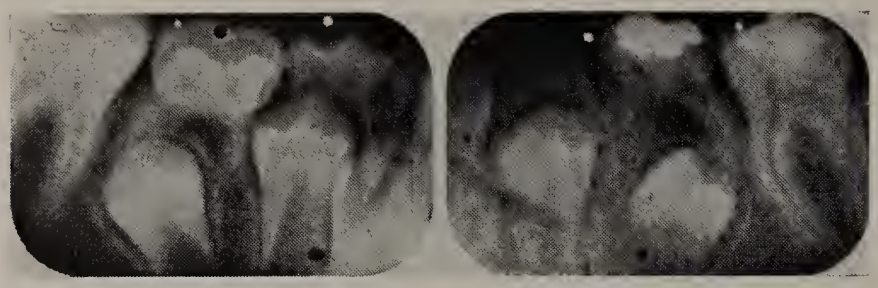


C. B. 8 yr. 9 mth. M. J. 10 yr. 1 mth.

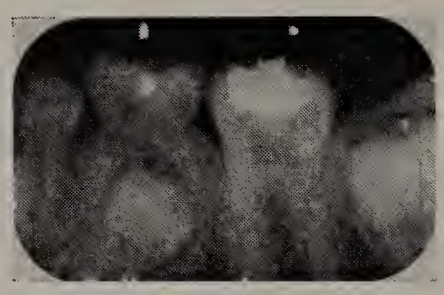
Fig. 6.—Mild distal inclination of premolars.

of the molar roots (*Fig.* 1). However, I hope to show that this may not necessarily be a typical pattern.

From about 7 years onwards, when we might begin to see our orthodontic patients, the premolars may lie within the confines of the deciduous molar roots irrespective of the chronological or dental age of the child (*Fig.* 2); or, less typically, they may lie at or below the level of the molar apices (*Fig.* 3)—occasionally so low that it might be thought from intra-oral X-rays that the premolars were missing altogether. There may even be a combination of both types on different sides of the same patient (*Fig.* 4).



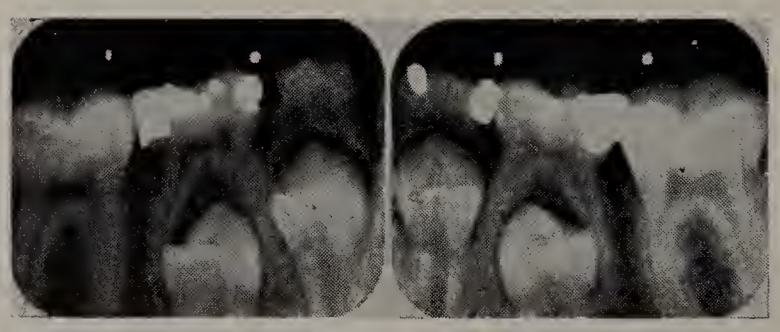
A. N. 8 yr. 10 mth. T. G. 10 yr. 1 mth.



G. S. 10 yr. 9 mth.

Fig. 7.—Marked distal inclination of premolars.

S. L. 8 yr.

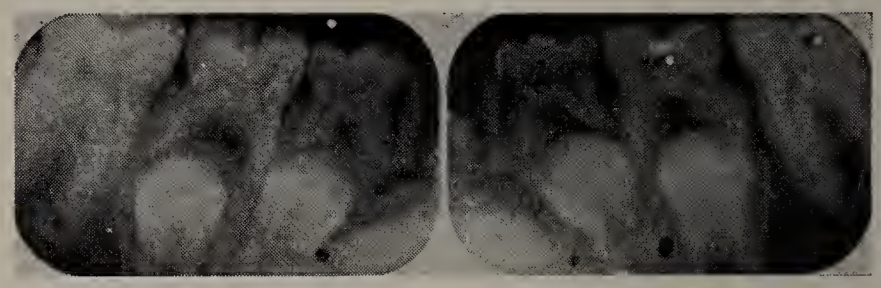


P. S. 10 yr. 2 mth.

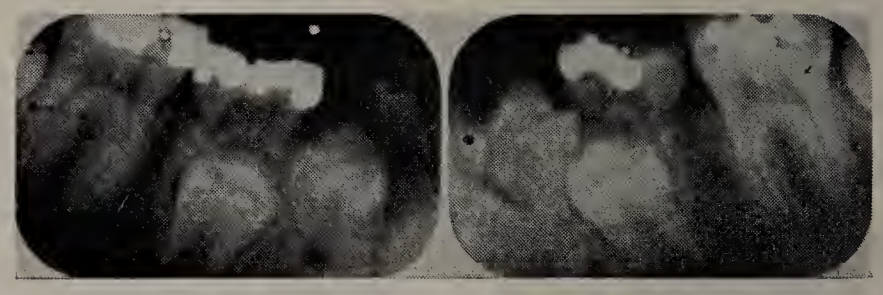
Fig. 9.—Rotations of premolars.

Another common variation is for the premolars to lie vertically under the distal root of the corresponding deciduous molars (*Fig.* 5).

An apparently similar, but significantly different problem, is seen when the premolars are not only under the distal root of the deciduous molar but are themselves inclined in a distal direction. The premolar inclination may vary from mild (*Fig.* 6) to quite marked (*Fig.* 7). Much less commonly the premolars are found to be inclining mesially (*Fig.* 8).



S. E. 9 yr. 6 mth.



J. G. 10 yr. 2 mth.

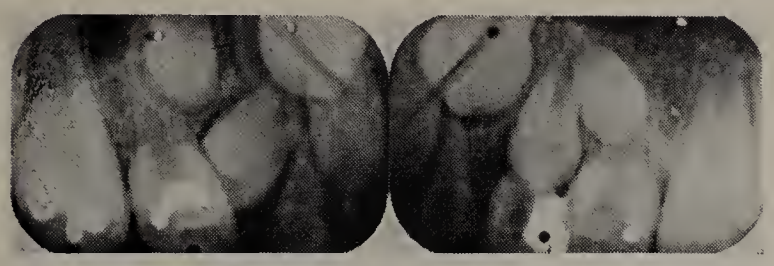
Fig. 8.—Mesial inclination of premolars.

Rotations of the premolars within their crypts are also seen (*Fig.* 9). The degree of rotation shows considerable difference from case to case.

All these variations of the premolars are seen in the maxilla as well as in the mandible, but they apparently occur less frequently in the upper jaw. This may be a basic fact, due to the containing action of the three-rooted deciduous molar; or it may be because the X-rays are more difficult to interpret due to greater superimposition (*Figs.* 10, 11). Another variation, noted only in the maxilla, is when the premolars on the same side appear to be on divergent axes, as if their apices had been compressed together and their crowns had moved into a space in which they could spread (*Fig.* 12).

Yet another variation is that the premolars may be obliquely placed in a buccolingual direction. This is difficult to prove radiographically, but it can sometimes be shown on

occlusal views where the inclination is sufficient to be seen beyond the superimposition of the deciduous molar crown (*Fig.* 13). Parallax views also demonstrate that the premolars can have a buccolingual tilt. Such inclinations might well be superimposed on any of the other previously described patterns.



C. S. 8 yr. 5 mth.

Fig. 10.—The picture on the *left* shows high position of $\underline{5}|$. The picture on the *right* shows distal inclination of $|\underline{5}$.

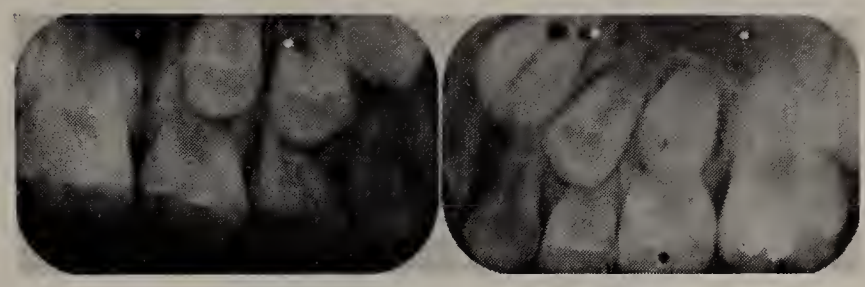
The different variations which I have enumerated are probably not new to any of you, but I cannot find a reference to a description of a similar series in the literature.

Having described these variations one must ask whether or not they have any clinical significance.

When one considers that the premolar begins to develop on the lingual and occlusal aspect of its predecessor, then it is not surprising that it does not always find its place precisely between the roots of the deciduous molar. To some extent the position must be determined by the shape of the crown of the premolar and the type of bifurcation of the deciduous molar, which may be narrow or broad, and the shape of its roots. Obviously a broad premolar crown cannot fit snugly into acutely angled deciduous roots; but most of the variations can only be explained by loosely stating that the premolar developed in an aberrant position. When these aberrations are mild there is probably no clinical effect, unless other factors superimpose. They can be described as variations of the normal and are largely self-correcting.

However, if the premolars are lying well below the bifurcation of the primary tooth this may be an indication to delay orthodontic treatment should extraction of premolars be contemplated as part of the treatment plan, because their late eruption may be expected.

Further, if the premolars are at, or below, the level of the deciduous molar apices, an attempt to move a buccal segment distally in the mixed dentition might leave the premolars unchanged in position.



S. M. 8 yr. 4 mth. S. B. 8 yr. 6 mth.

S. S. 15 yr. 5 mth.

Fig. 11.—*Top left*: Mesial position of premolars which are vertical; *Top right*: Mild mesial inclination of premolars; *Lower*: Marked mesial inclination of $|\underline{5}$.

A. W. 7 yr. 9 mth. S. F. 8 yr. 7 mth.

A. F. 9 yr. 3 mth.

Fig. 12.—Divergent upper premolars.

There are obvious warnings in treatment if the premolars are markedly tilted in any direction. This is particularly so when distal tilting occurs and the first permanent molars might have to be extracted; or conversely when first premolars are to be extracted and the second premolars are mesially inclined. Again, a distally tilted premolar may impact itself against a first molar. When the tilting

is mild and the mesial surface of the molar is not too bulbous the condition will be self-correcting; but gross tilting may present considerable problems to enable the premolar to be brought satisfactorily into the arch. Considerations such as these may modify a treatment plan. Similarly, if a rotated second premolar is recognized sufficiently early, it might be wise to mark such a tooth for extraction rather than the more popular first premolar.

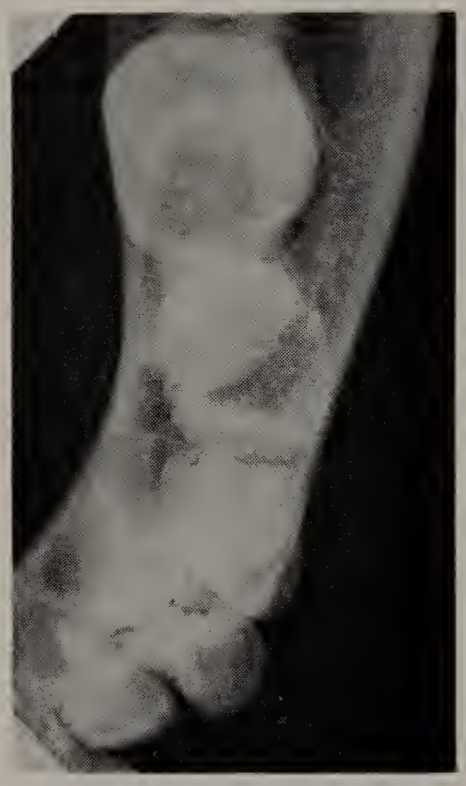
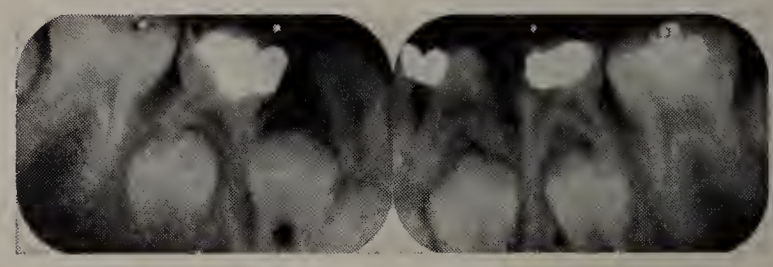


Fig. 13.—Occlusal view showing lingual position of $\overline{|5}$.

The problem which offers the greatest scope for speculation is when the premolar lies relatively vertically beneath the distal root of the deciduous tooth. A commonly associated finding is that the distal root shows considerably more resorption than the mesial root, which is sometimes hardly resorbed at all. The initiating process of resorption of primary teeth is not well understood, but one of the factors certainly concerned is pressure from the developing premolar. So the explanation of the uneven resorption of the molar roots may be quite simply that the premolar developed beneath the distal root of its predecessor, and pressure from the erupting premolar eroded the distal root of the deciduous molar.

However, there may be an alternative explanation. Scott and Dixon (1959) state, "With growth of the jaws the whole dentition, including both the functional and the developing teeth, moves through the growing alveolar bone . . . outwards and forwards." If the buccal segment, or possibly the whole arch, had moved forward more than normally, then there would be greater pressure of the distal roots of the deciduous molars against the premolars, and the pressure would be relieved from the mesial roots. This might well produce increased resorption of the distal roots of deciduous molars and allow the premolar to appear to be distal to its predecessor. In such an interpretation it is the premolar that is in the correct position and the buccal segment that is relatively forward, in contrast to the earlier explanation. In the case shown in *Fig.* 14 the patient has prematurely lost $\overline{D|}$ and $\overline{6E|}$ has tipped forward into the resulting space. The distal root of $\overline{E|}$ shows greater resorption than the mesial one. On the opposite side, seen in the picture on the right, there has been no early loss, but $\overline{|E}$ shows a similar resorption pattern of its roots. The first molars on both sides appear to be tilting forward, implying mesial migration of the buccal segments. Clinically, the case was an Angle Class II, division 1 with collapse of the lower labial segment, and the buccal segments appeared to have migrated forwards. If this explanation is true, then there might be a possibility of inferring from intra-oral X-rays the early recognition of mesial migration of buccal segments, particularly where there has been lingual collapse of the anterior segment.



S. W. 9 yr. 6 mth.

Fig. 14.—Left and right sides of same patient showing similar resorption patterns of $\overline{E|E}$ roots. *Note* early loss of $\overline{D|}$. There is an implication of forward migration of buccal segments (*see text*).

It is difficult to explain the significance of the divergent upper premolars. A possible interpretation is that this is associated with radiographic technique.

This investigation began as a simple problem from some chance observations, but the more one sees the greater are the factors involved. It is intended to continue the study on the following lines: further investigations to eliminate errors in the radiographic technique; a longitudinal study of children to follow the serial development of premolars; a statistical survey to discover the frequency of the premolar developmental variations, and to link these up with occlusal variations.

SUMMARY

1. An experiment in X-ray technique is referred to.

2. A series of variations in the developmental positions of premolars is described.

3. Some clinical considerations are suggested.

4. Further lines of investigation are indicated.

In conclusion, one might quote a remark of Professor Hallett, who once said, in a slightly different context, that when looking at radiographs of premolars it is not sufficient to say "all present"; one must say "all present and correct, or not correct".

Acknowledgements.—I should like to express my appreciation to Mr. H. E. Wilson and Mr. J. S. Beresford for encouragement and advice, and my thanks to the Photographic Department of the London Hospital for production of the illustrations.

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DISCUSSION

Mr. A. J. Walpole Day said that Mr. Rose had given him very great pleasure in asking him to open the discussion, because it was an aspect of development which he found most interesting. He would confine his observations to one or two points to stimulate further discussion.

A point arose from the fact that the crowns of the developing premolar teeth were widely separated and yet, when they were in occlusion, they were in contact. That was due to the fact that the deciduous molars were very much larger teeth than the premolars. In order that the crowns of the premolar teeth might come together, one or both of those teeth had to drift; presumably it was the five which drifted forward.

We know that the developing apical regions of any teeth are relatively stable in the bone so, if the five drifted forward, it must get a forward inclination. If one did not see much of a forward inclination in the erupted five, it was reasonable to suppose that the developing apical regions were fairly close together and the crowns divergent so that as the crown of the five moved forward it became uprighted.

If the developing premolars were vertical and widely spaced so that on eruption the five was inclined forward, then there would be a forward thrust on the tooth every time a child bit on that tooth, and if the developing premolars were inclined forward to start with, there would be an even greater inclination on eruption and consequently a greater forward thrust on occlusion.

He wondered if Mr. Rose, in the future, might consider whether that forward thrust would lead to incisor crowding later on, and whether, in fact, it was more normal to have diverging crowns in the developing premolars so that, eventually, they came upright and did not have the excessive forward thrust.

The second point he wanted to throw out was that he had noticed in those cases where children had ankylosed teeth fairly early on, say since the age of 3 or 4, in nearly every case the lower five was inclined distally. It had not been subjected to the forward migration transmitted to the crown.

Miss L. M. Clinch said that she had found the paper most interesting. There were a few questions she wanted to ask Mr. Rose.

First, it seemed to her that a large percentage of lower fives were rotated. Would Mr. Rose agree with that?

Secondly, in the cases where the lower fives were very low down at, say, 8 years, could that be simply because the whole development of the permanent dentition was late?

Thirdly, was a medial tilt of the lower fives as common as a distal tilt?

Fourthly, had Mr. Rose any idea of the percentage of cases in which the upper five erupted before the upper four because, from the clinical point of view, that was very important?

Mr. P. H. Burke said that, although Mr. Rose had not completed his statistical survey, he would like to ask if he had found any association between rotation of premolars and absence of their predecessors?

He wished also to comment on the point Mr. Walpole Day had mentioned. Mr. Walpole Day felt that the apical area was a stable area; he himself disagreed with that slightly. He felt that the apical area was a stable area when it was closed, but when a tooth was erupting the mechanism must permit movement of the apex in the direction of eruption. There could also be displacement of the apex either mesially or distally, if the tooth

was tilting as it erupted involving movement of the apex. If the apex was moving in this way at the time the apex was actually closing, that was the time when terminal dilaceration or bending of the root was produced.

Mr. A. G. T. Allcorn asked Mr. Rose whether there was any evidence of absorption of the mesial roots of deciduous teeth in buccal segments that have been moved distally by appliances.

Mr. J. C. Ritchie thanked Mr. Rose very much for his paper. He was particularly interested in the distal eruption of the lower second premolars because, although that was not very common, it was something every orthodontist came across from time to time.

It seemed to him that whatever was done in the way of relieving crowding in order to try to get a vertical eruption of those teeth, they appeared to continue on their accursed path. He wondered if Mr. Rose had any experience of relieving that path of eruption by surgical means of removing mesial bone.

Mr. Houston wondered whether Mr. Rose had considered using the alveolar border as a guide to the developmental stage of the patient. The reason he said that was, if MacHugh's recent work on eruption of teeth for his doctorate was considered, he discovered that the first thing that happened was a proliferation of the basal layers of the follicle. If the path of action of the oral epithelium of the follicle was either on the lingual or distal side, the eruption would be preceded initially by resorption of the distal or mesial root.

Before he came down, having read the title of the paper, he had looked up a whole series of premolar radiographs in his Department from the beginning of the year. He discovered the alveolar border to be useful as a guide because it could be used in cases where the deciduous molars had been lost. If the second deciduous molar was lost prematurely, the two premolars were at exactly the same eruptive heights relative to the alveolar border in nearly every case, so there was a definite relationship to the loss of the deciduous premolar as well. Had Mr. Rose found evidence of that?

Mr. Rose, in reply, thanked Mr. Day for his introduction and initial stimulus. He did not know about ankylosed teeth and distal inclination. He had not associated that; it might well be. One was continually seeing more in the pictures each time one looked at them.

So far as drift of premolars was concerned and Mr. Day's interesting suggestion, that would have to be looked at. He suspected that the teeth could go bodily through the bone, but the serial X-rays he suggested doing would probably be the answer to that question.

In reply to Miss Clinch and the percentage of second premolars rotating, he said that was a relative question and he did not know the answer in figures. It was common to find small degrees of rotations which were self-corrective on eruption and some of those, he thought, were due to the X-ray tube being pointed mesially or distally and implying a rotation.

With regard to the point on the position of molars low down being associated with late development; he had once thought that would be an answer, but he thought now that it was possible there would be different developmental ages on each side of the patient and, referring to one of the slides he had shown with two cases with a left and right at different heights, the amount of root formed on two premolars on each side was similar; so he did not think that was the whole answer. It might be part of it.

Distal inclination was much more common than mesial in the lower. He had the impression that it might be the other way round in the upper.

As to which came first, the upper or second premolar, that was not part of the investigation. He was pretty certain in his own mind that it was the first premolar. It was rare to see the first premolar locked out but common to see the second premolar locked out.

In reply to Mr. Burke, he did not know if there was any association between the rotation of premolars and the absence of predecessors.

Mr. Allcorn's question he could only answer by implication. It was an obvious follow-up of the suggestion that buccal segments could go forward. He had not done that very much and had not checked it by X-ray when he had done it. The only indication he could suggest was that one sometimes found, when the lower second deciduous molar was lost early, the first one tipped back into the space. On those occasions, the mesial root was resorbed more rapidly than the distal root. It must be something to do with age, so that some roots were more ready to resorb than others, and you could get away with something one day and the next day you were disappointed because it did not work.

In reply to Mr. Ritchie, he had not tried to relieve those things surgically. He thought that if the inclination was such that the premolar were really impacted against the six, a mild distal inclination would "shimmy" itself up the mesial wall of the first molar. A marked inclination might involve the removal of the bone as well, but it would not be difficult to put a pin in at the same time.

Mr. Houston's suggestions were very interesting. A premolar did take the easy way out; any tooth took the path of least resistance. Whether the tooth was lingual, mesial, or buccal did not matter. It was something one could look for in relation to the alveolar border.

With regard to premolar heights, one needed to do more on that.

The President thanked Mr. Rose, Mr. Day, and those who had taken part in the discussion. Mr. Rose had been a little concerned that they would not find his subject large enough to entertain them, but everyone would agree that he had been wrong about that.

He was particularly interested in Mr. Rose's remark that the more one looked at X-rays the more one could see. So many of us, under pressure of work, just held films up to the window and if there were some teeth, thanked our stars and put the films rapidly back in the envelope. One found, in helping students when they came to clinics at hospital, that they took quite a little time to learn to observe what could be seen on an X-ray, if it was properly looked at. He was sure that they would find an immense amount of information if they would give more time to improving their techniques in reading and taking X-rays.

He was amused at the thought of premolars "shimmying". It must have entertained Mr. Rose as he prepared the paper.

THE CLINICAL SIGNIFICANCE OF INNATE AND ADAPTIVE POSTURES AND MOTOR BEHAVIOUR

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Lundström (1949) said, "the conclusion of my investigation is, then, that the causes of malocclusion seem to a high degree to be hereditary in nature". Most orthodontic clinicians of experience would agree with him. There is no doubt, however, that far too much time and money are spent on orthodontic treatment planned with the supposition that abnormalities of occlusion arise as the result of environmental factors which can be controlled by therapy of one sort or another.

One purpose of this paper is to demonstrate how evolution of thought in relation to clinical research and experience can be correlated to the concept that malocclusions are inherited, and, furthermore, to demonstrate the mechanisms involved. Another way of putting Lundström's conclusion is that malocclusions are an expression of the inherited variability in a population and only in a very small percentage of cases might they be due to pathology and environmental factors. Inherited characters arise on the basis of natural selection from the inherent variability within the gene pool of a population and then through the genetic control of growth and development and the genetical determination of behaviour of the neuromuscular mechanism in the individual. In the developing individual the form of some structures is primarily determined by inheritance, for instance, muscle and bone with limited modifications as the result of function, whereas other structures have the power to adapt to function. Ligaments, tendons, aponeuroses form from undifferentiated connective tissue in response to stresses and strains put upon them as the result of function. Furthermore, it is now universally recognized by biologists that basic motor behaviour is built into the individual by inheritance and not learned by trial and error. For the evidence on this *see* Tinbergen (1951), and Thorpe and Zangwell (1961).

It can be visualized, then, that the genetically determined characters of muscle and bone are laid down in the embryo with all their inherent variability and they are related to one another through the adaptive properties of connective tissue and joint cartilage. The crux of the matter in clinical orthodontics would appear to be, then, what is inherited and what is adaptive? What is the extent of the adaptation in the orofacial complex? In therapy, how can the orthodontist use the adaptive ability of tissues to maintain permanent changes in the occlusal relationship?

Although the main purpose of this paper is to discuss the innate and adaptive characters in soft tissue, brief mention must be made of the result of cephalometric analysis over the last fifteen years or so, originating from Broadbent (1931), which indicates very clearly that the skeletal pattern of an individual does not change significantly either with growth or as the result of orthodontic treatment. There are those wishful thinkers who believe otherwise, but in the author's view no useful purpose is served by discussing this further.

However, originating from the work of Brodie (1938), an overwhelming amount of clinical evidence has accumulated that shows that orthodontic treatment depends for its success in changes within the dento-alveolar structure. Following on from this observation, again with all the further accumulating evidence on the rest position of the mandible, a concept has evolved that the dento-alveolar structures are adaptive to their soft-tissue environment; adaptive to produce an occlusion within the inherited variation of the skeletal

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pattern. The skeletal pattern is determined by the form of the bones and by muscle posture. Furthermore, the dento-alveolar structures are adaptive to the linguo-facial environment formed by the form and posture of the soft tissues. Alveolar bone develops in response to the presence of teeth; it is adaptive to produce a normal occlusion in a wide range of variability of dental base relationships in all three dimensions. The adaptive character of the dento-alveolar structures maintains an occlusion through normal wear and tear of the dentition; in cases for instance of extensive attrition, and even in such pathological disturbances as cases of unilateral condylar hyperplasia.

It is a further purpose of this paper to describe the soft tissues in terms of the characters that are inherited and those which are adaptive. Before doing so, however, a brief history will indicate how thought has evolved in relation to clinical practice. Twenty-five years ago the exercises of Rogers and others were much in vogue to adjust jaw relationships; lip exercises and breathing exercises were used for the mouth-breather. At this time it was thought that mouth-breathing was the cause of abnormal development of the maxilla.

Many orthodontists, including the author, were at this time sceptical of the value of such re-education exercises, but it was not until radiographic cephalometric methods were evolved that it could be demonstrated quite clearly that they did not achieve differential growth of the mandible to alter the skeletal pattern. Nearly twenty years ago, Gwynne Evans began his work on the open lip posture and mouth breathing. By 1951 he had demonstrated that neither exercises, conscious effort, nor reflex approach with a monobloc were of any great value in the re-education of what were then called "abnormal postures and behaviours". Since then, clinical work has demonstrated very clearly that individuals have characteristic postures and patterns of movement which are peculiar to themselves and over which orthodontists and speech therapists have no control. Ballard (1956) reviewed the biological support for these observations and came to the conclusion that it was possible to analyse both posture and behaviour on the basis of endogenous posture and behaviour and habit posture and behaviour, the word "behaviour" here being used in the restricted sense of pattern of movement. By "endogenous postures and patterns of behaviour" were meant quite distinctly those which arose as the result of inheritance and were not the result of trial-and-error learning through proprioceptor and other sensory receptors. By "habit postures and behaviours" were meant those which arose as the result of sensory experience or perhaps more rarely as the result of external environmental factors, although the latter play very little part in the development of habits in the normal individual. These conclusions are in line with present-day biological concepts which have been previously mentioned. The use of the word "endogenous" was proposed following its use by Gesell (1942) in reference to the development of orofacial behaviour. It was used to replace the term "physiologic rest position" (Thompson, 1946). The reasoning then was that the rest position or "physiologic rest position" as it is seen in the orofacial complex is not the result of inherent resting tonus in each individual muscle reciprocally producing posture. It was thought that if this were so, the posture would not be maintained when the head and neck changed their relationship to the force of gravity, and certain physiological requirements would not be met. For instance, a newborn infant lying on its back would suffocate. It was reasoned that posture must arise from within the central nervous system and that it would be maintained whatever the relationship of the body to the force of gravity. This view may have to be modified as the result of the recent work by Joseph (1960) which has confirmed that of Tulley (1953) and Shpuntoff and Shpuntoff (1956) with regard to the electromyographic silence which is noted in posture. Incidentally, these observations must modify the attitude of the physiologists.

Best and Taylor (1950) say that "muscle tone is the steady reflex contraction which resides in the muscles concerned in maintaining the posture characteristic of a given

species". Wright (1952) says that "tone is the result of low frequency asynchronous discharge from the ventral horn cells producing a partial tetanus which is economical and can be long maintained". Joseph (1960) has demonstrated that posture can be maintained with muscles in a "relaxed position", as he calls it. He says relaxed muscles show no detectable activity. He then goes on to say, "that there are differences between a relaxed muscle with an intact nerve supply and a denervated muscle is undoubtedly true, but these do not appear to be due to the contraction of a few motor units in the former as compared with the latter". It is very evident that this position, as referred to by Joseph, is the one that orthodontists see clinically as being the "endogenous" or "built-in" or "innate" posture of the individual. It may be, then, that the actual patterns of the muscles are determined genetically and that these patterns are correlated to the genetically determined skeletal form through the adaptive behaviour of the connective tissue. It is essential that posture be maintained even against the force of gravity and, as far as the head and neck are concerned, altering relationships to such force of gravity. Adjustments, in these circumstances, are most probably initiated from the central nervous system as the result of the proprioceptor information feed-back mechanism. The term "endogenous posture" will be used in the remainder of the paper, and will be regarded as being synonymous with "the relaxed position" of Joseph.

A succession of papers over the last fifteen years has described postures and patterns of behaviour of the orofacial soft tissue, which can now be divided into "endogenous postures and patterns of behaviour" and "adaptive postures and patterns of behaviour". At this point the extent of normal variation and the necessary adaptive behaviours that have been described in the past must be summarized. Endogenous posture in the lips varies from individual to individual in any racial group and from one racial group to another. The lips may be together or they may be very wide apart (the incompetent lip posture). They may be full and everted, resulting in a bimaxillary proclination as in some racial groups within the Caucasian or as in the negroid. They may, on the other hand, be in a posture which results in a bimaxillary retroclination of a typical Angle's Class II, division 2 incisor occlusion. In all these variations, there is endogenous posture in the muscles, and it is misleading to refer on the one hand to the lips being "hypotonic" and on the other hand to their being "hypertonic", or to refer to the muscles as having "hypotonicity" or "hypertonicity". It must be stressed that the last fifteen years of study of these variations of endogenous posture indicate quite clearly that it is not possible to re-educate them to produce another posture which is still maintained with the muscles in this relaxed position. On the other hand, those individuals who have an endogenous posture of lips apart demonstrate very well "habit posture". Walther (1960) came to the conclusion that only 18 per cent of the population that he studied had a "competent lip posture"; in other words, only 18 per cent maintained an anterior oral seal with the musculature of the lips in this endogenous posture. However, a much smaller percentage of the population go about with their lips apart. The remainder maintain an oral seal by circumoral muscle contraction, that is, a habit posture. This habit arises quite subconsciously and reflexly—it might be said, instinctively. A smaller percentage of the population, however, has such a degree of lip incompetence that they cannot maintain the muscular effort necessary for an anterior oral seal by means of a circumoral muscle contraction and they, again quite instinctively, adopt another pattern to produce a seal. Almost invariably they will use the tongue between the teeth against the lower lip, the upper lip remaining as a rule in the endogenous posture; the lower lip, however, showing increased muscle activity (an isometric contraction) to maintain contact with the tip of the tongue. When there is this lip-to-tip-of-tongue contact to maintain an anterior oral seal, then the tongue will be seen to thrust during swallowing and there will be increased circumoral effort. This will be referred to later.

Furthermore, when associated with the use of the tongue against the lower lip, there is also an increase of overjet and perhaps a considerable postnormality of the mandibular dental base, then the mandible will be postured downwards and forwards as part of the adaptive habit to produce a seal. As far as the tongue is concerned (Ballard, 1959), it is now possible to recognize the endogenous posture and also to recognize that variations in the skeletal pattern can be correlated to variations in the relationship of the dorsum of the tongue to hard and soft palate. In this paper it was pointed out that the assumption that the tongue usually fills the oral cavity appeared to be quite unsound. Lateral skull radiographs taken with the individual so postured that the afferent side of any habit posture was broken showed that the tongue tended to drop away from the incisor teeth back into the floor of the mouth. In those individuals and racial types with large oral cavities, the tongue frequently appeared to be quite inadequate to fill the space within the dental arches, but it invariably, in the habitual posture, made contact with the incisor teeth and flattened out to make contact with the lateral aspects of the dento-alveolar structures. Anteriorly it maintained a seal against the incisor teeth and laterally a seal from the floor of the mouth. In such cases the tongue is frequently in a thrust forward position to maintain contact with the incisor teeth and is not maintaining contact with the soft palate.

As the result of further observations Ballard (1960) postulated that the tongue adopted a posture quite instinctively for two physiological purposes. The one was to maintain a seal against the incisor teeth and to assist in an anterior oral seal by contact with the lip, as will be seen later. The other was to maintain contact with the lingual aspects of the dento-alveolar structures of the upper or lower arches, most probably for the purpose of keeping the floor of the mouth clear of saliva and collecting saliva on the dorsum of the tongue preparatory to being swallowed.

These observations on the adaptive behaviour of the tongue lead to the conclusion that the determination of incisor position is primarily due to the posture and morphological characters of the lips. Only secondarily does the tongue, as the result of this instinctively adaptive behaviour, mould and balance them from the lingual aspect. This accounts for the fact, as previously noted, that, when the support of the buccal segments is removed from the labial segments, they will only drop back a limited amount (Ballard, 1957).

With regard to behaviour, the basis of any pattern of movement is innate, but modifications are produced by feed-back control from sensory receptors or proprioceptors, in the same way that posture is modified. Furthermore, the movement to and from a habit posture is necessarily reflexly adaptive. Instances are the circumoral effort to resist the tongue thrust in swallowing when there is a lower-lip-to-tongue contact in the habit maintenance of an anterior oral seal, or the movement of the mandible in speech when habit forward posture is part of the maintenance of an anterior oral seal. There are, however, variations of innate behaviour which are frequently the main morphological feature in a malocclusion. First, in the use of the muscles of the face for expressive behaviour, there are distinct racial variations (Huber, 1931) and facial expression has individual character. A particular endogenous pattern which is recognized is that of the firmly retracting lower lip with an upper lip that may evert or even retract upwards. Such expressive behaviour associated with even the mildest of Class II dental base relationships will produce a Class II, division 1 incisor relationship which cannot be permanently reduced by orthodontic treatment. Almost invariably in such cases there is an incomplete overbite because of the persistent use of the tongue against the lower lip in the maintenance of an anterior oral seal. This is an adaptive use of the tongue. There is also an endogenous behaviour of the tongue which is frequently difficult to differentiate from the lip-to-tip-of-tongue contact and subsequent appearance of thrust in swallowing which has already been mentioned. It was originally noted in 1937 (Froeschels) that when an open

bite, tongue thrusting, and sigmatism were present together, the sigmatism appeared to be a fault of tongue behaviour, protrusion of the tongue being performed with undue effort. In only 6 cases out of 100 examined was the open bite sufficient to permit the protrusion without an opening of the jaws. Rix (1946) analysed tongue thrusting in relation to occlusion, and Cauhépé and Fieux (1954) showed that at least in some cases it appeared to be inherited. Distinction, then, has to be made between the adaptive thrust of the tongue and the endogenous thrust of the tongue. Endogenous behaviour is most obvious when it produces an open bite or an increase of overjet, when the other morphological features of the individual would result in a normal occlusion. Brief mention must be made of the tooth-apart swallow. A tooth-apart swallow will occur whenever swallowing is performed in association with an adaptive downward and forward posture of the mandible. This will occur, as has already been mentioned, in Class II, division 1 labial segment relationship types and, as has been previously mentioned (Ballard, 1959), it occurs in Class II, division 2 malocclusions. In such cases it has no significance. It also occurs in the endogenous tongue thrust in some cases as has been noted by Froeschels.

Investigations on endogenous posture of the mandible and on masticatory activity by such people as Perry and Harris (1954), Thompson (1946), Grewcock and Ballard (1954), and Thomson (1959) support the physiological approach which is being put forward here. The only reasonable explanation for clinical experience with "abnormal paths of closure" (bites of accommodation) would appear to be that they are the result of reflex control of endogenous patterns of behaviour (Ballard, 1957). Abnormal cuspal relationships produce a movement of the mandible away from centric jaw position to avoid trauma to the supporting structures of the teeth. It is an important piece of evidence that clinical experience is that immediately such abnormal tooth relationships are dealt with, the individual will revert to a normal path of closure, that is, the endogenous pattern of movement. The chopping bites which occur in such types of malocclusions as Class II, division 2 without resulting trauma are indicative of the control of endogenous patterns of behaviour as the result of the feed-back mechanism from the proprioceptors in the periodontal membrane. The sensory receptors have phylogenetically been very important from the point of view of the survival of the dentition. They are continuing to be important, because they enable adaptation to the extensive variability in the population which would not have been compatible with survival in our ancestors.

So far it has been stated that individuals inherit characteristics of posture and behaviour, and that superimposed on these there will be, quite reflexly and instinctively, habit postures and habit patterns of behaviour which adapt to inherited variations for certain physiological requirements. What are the physiological criteria which determine the particular pattern of habit posture or behaviour? The most important is that there has to be a physiological necessity, such as, for instance, the maintenance of an anterior oral seal. The physiological necessity involves afferent stimuli which produce and maintain a posture or which control innate behaviour patterns. The next is that of physiological economy. In quoting Wright at the beginning of the paper, it was pointed out that postural tonus is economical and can be long maintained. We now know from Joseph's work that he regards it as "a relaxed position"; such a relaxed position being the most economical physiologically for the particular muscles. Again, referring to the lips, there is the habit posture of circumoral contraction to overcome the incompetent lip posture. Alternatively, as previously mentioned, there are those individuals with such a degree of lip incompetence that the muscular effort to maintain a seal by circumoral contraction is much greater than the alternative of a contraction of the mentalis and orbicularis muscles of the lower lip against the tip of the tongue. This alternative is the most physiologically economical; it comes about quite instinctively. If an attempt is made either by conscious effort or by retraining exercises to produce a lip seal posture

in these cases, the physiological effort will be too great and the individual will inevitably revert to the more economical habit, although the posture might be maintained for a time, perhaps only during visits to the dentist or speech therapist. Since this concept of physiological economy as a basis for adaptive postures and behaviours was put forward (Ballard, 1960), it has been brought to the author's notice that Zipf (1949) had demonstrated very clearly that all human behaviour was based on and motivated by the principle of economy of effort. Zipf was thinking in terms of total behaviour; in orthodontics we are more concerned with the limited aspect of motor behaviour.

It is the author's contention that on this physiological and biological approach (which has been formed as the result of clinical experience) orthodontics has now reached a stage when, so far as most malocclusions are concerned, it is possible to analyse soft-tissue and skeletal features and plan treatment in such a way that the teeth are put into a stable position, such a position being maintained by posture and behaviour which are within the physiological capabilities of each individual. In this brief paper it is not possible to discuss in detail the limiting factors of all the variations of soft and hard tissues which have been described since 1947, which have demonstrated that the degree of change of tooth position which will remain stable in any particular individual is strictly limited and related to inherited features. This is particularly so in Class I, Class II, division 2, and Class III malocclusions. It is, however, a little different with Class II, division 1 malocclusions in that adaptive behaviours can be changed. They have to change quite reflexly as the result of tooth movement. A new position has to result in adaptive posture and behaviour which are either as physiologically economical as or even more economical than those which came into being quite instinctively with the growth and development of the individual, and which, incidentally, moulded the dento-alveolar structures to produce an abnormal occlusion. For instance, when in treatment the upper labial segment is retracted from a position outside the lip to a position inside the lower lip, then the muscle contraction to produce an anterior oral seal by lip contact has to be physiologically as economical as the previous pattern, which was most probably a contraction of the lower lip behind the upper incisor teeth against the tongue which is thrusting in between the incisor teeth (Ballard, 1960).

However, as was pointed out, with incompetent lip morphology some of these adaptive behaviours cannot be changed because the effort required is too great to be maintained. In such circumstances complete reduction of the overjet will relapse, the individual continuing to maintain an anterior oral seal by using lower lip and tongue. Such cases show extreme morphological variations which produce Class II, division 1 malocclusions. They have a high maxillary mandibular plane angle, a severe degree of post-normality of mandibular dental base, and a moderate to a severe degree of lip incompetence. Furthermore, as a rule they show a low tongue position which may not make contact with the soft palate when it is maintaining an anterior oral seal. Such cases may not be common in the general run of clinical practice, but they certainly are quite common in those cases referred to the orthodontic department of a hospital. Much time and energy are still being expended in an endeavour to re-educate that which is loosely referred to as "perverse orofacial behaviour", partly because changes do occur in relation to such re-education therapy in a certain number of cases. The interpretation of these associated changes, however, is incorrect. In most cases the changes in tooth position would have occurred without the re-education therapy. For instance, as far as the lips are concerned, there are borderline cases of lip incompetence who before puberty will go about with their lips apart using tip of tongue to lower lip. These individuals, perhaps using a little conscious effort because of more awareness of their appearance, may change to a lip seal by greater circumoral muscle effort, but with less tongue to lower lip effort. Cases do occur in which it is just vanity that maintains this lip seal over

the immediate post-puberty period; the individual later relapses to a lips-apart posture which is the more economical physiologically. The much more important behaviour which it is thought can be changed is that of tongue thrust. It is evident from what has been said that the endogenous (innate) tongue thrust must be separated from the habit tongue thrust. The endogenous tongue thrust will produce an anterior open bite, with perhaps a certain degree of overjet when associated with a mild degree of postnormality of mandibular dental base in cases in which, from the other morphological features, one would expect there would have been a normal labial segment relationship. However, as has previously been reported (Ballard, 1957), such an open bite at the time of eruption of the incisor teeth slowly reduces, until at the age of 11 or 12 years it may have disappeared completely. In spite of the fact, however, that it has disappeared, the tongue thrust as analysed by speech thcrapists is still of the thrusting type. Note Froeschels' findings of an opening of the jaw in such cases. More often than not during the developmental phase, when the open bite is closing, the speech improves and the sigmatism may disappear completely. In other words, the individual, through auditory perception, makes better adaptation of his own endogenous behaviour in the articulation of the language. It is important to appreciate that prolonged treatment against tongue thrust may do harm (Ballard, 1953). The time at which an anterior open bite associated with a tongue thrust starts to close up, that is, at about 8 years of age, is quite frequently the time at which speech therapists attempt re-training activities. The concomitant closing up is thought to be a success of the re-training therapy.

Straub (1960) has postulated that tongue thrusting (reverse swallowing) and the concomitant "perverted orofacial musculature", as it is referred to in American literature, arise from the use of a long teat in bottle feeding. This theory does not bear close examination in the light of studies by ciné-radiography of Ardran and Kemp (1958), showing the behaviour of the human nipple in infant feeding, and the observations of Gunther (1955) that a long human nipple is a necessary environmental stimulus to bring out the innate suckling behaviour of the neonate.

Finally, a word must be said about the posturing of the mandible. The downward and forward posture in Class II, division 1 and Class II, division 2 cases has already been mentioned. There is a type of Class II, division 1 case in which the morphological features are such that, as the labial segments develop vertically, the individual produces a seal with the lower lip behind the upper incisor teeth against the tongue which comes over the lower incisors (Ballard, 1957). When this relationship is associated with a low maxillary mandibular plane angle, a high tongue position, and little or no lip incompetence, then the change from the pattern of anterior oral seal just described to a forward posturing with production of an anterior oral seal with lips in contact is easily accomplished, particularly if an appliance is inserted to retract the upper labial segment a fraction. In such circumstances it is physiologically just as economical to adopt the second type of posture. This change is easily induced by an Andresen appliance. In such circumstances the therapist claims that the mandible has been repositioned, the muscles re-educated, and some even infer that the condyles will grow back. In fact it was pointed out in 1957 (Ballard) that the mandible is forward from its endogenous posture and moves back to centric jaw relationship for mastication. It is evident that there is no true repositioning of the mandible. An important piece of evidence to support this analysis of such cases comes from those Class II, division 1 malocclusions in which the reverse occurs. They present with a forward posturing habit to produce an anterior oral seal and for speech. After treatment which reduces the overjet there is no longer forward posturing and the mandible is habitually more posterior (Ballard, 1951). This clinical experience explains the findings of Ricketts (1952).

Before summing up, it is of interest to relate this approach to orofacial morphology

to the articulation of language. Ballard (1961) said that because of the relationship between inherited morphological variation and adaptation as described, it is no longer possible to believe that speech patterns, which are acquired early in the child's life, are firmly imprinted in the central nervous system and difficult thereafter to eradicate. Children adapt to the changing position of the teeth during orthodontic treatment. This is over a matter of months perhaps, but they will adapt in a matter of twenty-four hours to the changed shape of the oral cavity when bulky removable appliances are inserted. Furthermore, Ballard and Bond (1960) have found definite correlations between variations in orofacial morphology and behaviour and variations in the articulation of some phonemes.

As a result, they believe that the same biological and physiological principles can and should be applied to the study of the articulation of language and dialects. They say that in any community the articulation of acceptable speech varies, such variation being related to the inherited and adaptive behaviour of each individual, and that some articulatory defects are due to inherited variations not permitting easy physiological adaptation.

Just after this latter paper was published, it was brought to the authors' notice that Darlington (1947) had written a paper proposing that there were "genetic components of language". Recently, Brosnahan (1961) has examined Darlington's hypothesis in great detail and all the evidence that he has accumulated supports him. Brosnahan says, "A survey of the possible factors influencing the speakers of a language in the selection of articulations seemed to indicate, surprisingly enough, that neither the language itself nor the culture or physical environment of its use exerted any appreciable influence on the process and that the major factors were to be sought within the speakers themselves." In other words, in a population or language group the basis of articulation and its variations are the genetically determined character in the orofacial complex.

CONCLUSIONS

An objective approach to an analysis of the relationship between tooth position and orofacial posture and behaviour has necessitated an abandonment of the old concepts and the development of an approach based on biological and physiological principles. It would appear that every individual has a genetically determined posture, which can be called the endogenous posture, and genetically determined patterns of behaviour. These are the basis for all motor activity. The orthodontic problem arises from the fact that some inherited variations in the morphological features of the jaws and soft tissues necessitate reflexly produced adaptive habits and patterns of movement for certain physiological requirements. A combination of innate and adaptive characters in posture and behaviour produces malocclusions. It is possible to analyse in detail the relationship between posture and behaviour and the dental arch position. It is most unlikely that the variations in orofacial behaviour which have been referred to as adaptive habits are the result of environmental factors. They do not fall into the category of perverse habits, which have arisen *de novo* as the result of psychological stress —mouth breathing, television viewing, etc. They arise quite reflexly and subconsciously. Because of this, re-education of the particular habit pattern seen in association with a malocclusion has no useful purpose in orthodontic therapy. Attempts at re-education throw physiological and psychological strain on the individual and psychological strain on the family as well. If new patterns are required to maintain an orthodontic treatment, then those patterns must come about quite reflexly as the result of that orthodontic treatment, and they must be physiologically economical for that individual or they will not be maintained. Orthodontic treatment carried out with these principles in mind does not require prolonged retention of the new tooth position. A knowledge of the biological background and the physiological make-up of the individual suggests that they are not as plastic in their environment as most re-education and re-training theories require.

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DISCUSSION

Mr. W. J. Tulley said that one of the points he would agree with most strongly was the condemnation of those people who were trying to sell re-educational exercises.

He did not want to say too much, but the basis of what Professor Ballard had told them was that the shape and size of both the hard and soft tissues had a genetic origin. The size and shape of these structures dictated various adaptation or habit postures and behaviours.

Professor Ballard had shown a case where he described an endogenous tongue thrust as having less and less effect on some dentitions as they developed. This was confusing because one usually has the endogenous tongue thrusts with very adverse occlusal effects.

In trying to understand lip and tongue posture, tongue posture particularly, static lateral skull X-rays were inadequate. He thought it was still necessary to use ciné X-ray film, because from posture came behaviour and the two had to be studied together.

Mr. W. A. B. Brown asked in what sense Professor Ballard was using the terms innate and endogenous. Work by Reiss and others, quoted by Lehrman (1953), raised the whole question of what was inherited and what was learned. Reiss raised rats in isolation and prevented them from ever manipulating or carrying any objects; the food was in powder form and the floor of the cage was of net so that the fæces fell through. Subsequently, when the rats were bred they did not build nests nor did they retrieve their young. It would seem that the rats never acquired the basic mechanism of picking up and so were unable to build nests. Furthermore, if the normal temperature is raised, rats do not build nests. These two examples suggest very strongly that so called instinctive activities may be expressions of learning and environment as much as of inheritance.

One questions whether behaviour itself is inherited. Could it not be that such complex activities as swallowing are in fact learned and inheritance is related only to the morphology of the jaws and muscles?

Mr. S. Haynes asked if Professor Ballard had any figures for the incidence of the endogenous tongue thrust. Secondly, he asked how the endogenous tongue thrust was differentiated from the habit thrust. Thirdly, how did that affect treatment, and fourthly, would Professor Ballard consider an abnormal path of eruption of the incisors as being a factor in the actiology of Class II, division 1 incisor relationship?

Mr. R. A. Campbell thanked Professor Ballard for his paper. He wished to suggest one possible line of inquiry. If in point of fact the reason why some people who could not pronounce "th" readily was due to the innate tongue position, would it not be possible to follow up the second and third generation of those people living in this country who had been brought up and educated in this country and found no difficulty in pronouncing "th"? Would their ability to pronounce "th" be an adaptive pattern from the original inherent innate pattern?

Miss L. M. Clinch said that she had a few simple questions to ask. If she had heard Professor Ballard correctly, he had said that bimaxillary protrusion was due entirely to lip posture. But did he not think that racial skeletal form could produce what we would call bimaxillary protrusion in Anglo-Saxons? Later on in the paper, Professor Ballard had said that bimaxillary protrusion was untreatable; the incisors could not be retracted because their position was due to lip posture which apparently could not be altered. But she had treated one of those cases. The child was now a woman and there did not appear to be any relapse, but that might be the exception that proved the rule.

Another point she wanted to find out was, did Professor Ballard always find there was pain with an adjusted bite, or cross-bite, eventually?

Probably the end of the paper answered this, but there was a higher percentage of children going around with their lips apart than adults, so presumably that cured itself with time and quite apart from orthodontic

treatment, was this so? She would like, once more, to register an objection to the term "incompetent" as applied to the lips. Even as defined they were competent in mastication and for speech, surely two of the most important lip functions; it was a misleading term and for that reason a bad one to teach to students.

Mr. T. Smith asked whether, in the case of the anterior open bite and endogenous tongue thrust, when that was corrected with an appliance and the appliance was completely left out and it was a case where the incisors remained in occlusion, if Professor Ballard sometimes found that bilateral open bite occurred later on in the premolar region in the permanent dentition.

Mr. W. A. Nicol wanted to ask one rather practical question about cases that had been treated that had incompetent lips. Could Professor Ballard say a little more about whether he said anything to the children to try to get them to produce an adaptive reflex closure of the lips; if so, what sort of psychological sales talk did he put across to them?

Mr. A. G. Batten returned to the speech problem. How was it that a family coming from the West of Ireland talked about going to the "tayahter" and their children always went to the "theatre"?

Mr. J. S. Beresford said he thought all those with artificial dentures kept their lips together. Would Professor Ballard comment on that? Did it arise from physiological economy or from a fear that the prosthesis would come adrift?

Mr. W. Marsh asked if there were any descriptive characteristics of the type of lip that produced a bimaxillary proclination.

Mr. D. I. Smith asked Professor Ballard whether he found evidence of palatal tilt of the upper buccal teeth in cases with a low tongue position.

Mr. D. A. Plint asked Professor Ballard to comment on a recent paper published in the *South African Journal of Hypnosis* and its effect on soft-tissue behaviour. There had been an attempt under hypnosis to alter the habit activity of the tongue. Did Professor Ballard think, as it was directed at the central nervous system, it would have any lasting effect on the individual?

Professor Ballard, in reply, said that he had, as Mr. Tulley said, oversimplified the question of endogenous tongue thrust. There are varying degrees of this type of behaviour. At the one extreme there is that which produces an open bite in the mixed dentition stage, but its influence on the labial segment is such that at the end of the mixed dentition stage there is no longer an open bite. At the other extreme there is persistent open bite throughout life.

With regard to the percentage of lip incompetence, Professor Walther's figure is that only 18 per cent of the population is in fact competent. He agreed with Mr. Tulley that it is quite impossible to take any notice of those writers who show radiographs or lateral skull tracings which appear to indicate that the mandible has been made to grow forward, unless the authors indicate very clearly indeed that they know all about postures and, in particular, habit postures.

Mr. Brown had referred to rats in reference to behaviour. Professor Ballard said that he had been very careful to stress that when he used the word "behaviour" he meant patterns of movement. He did not mean "total behaviour". There had, of course, been some misunderstanding about rat behaviour. They are inquisitive animals and this inquisitiveness had led earlier research workers to think that they were capable of learning. Animals inherited mechanisms which, in relation to certain environmental situations, could imprint behaviour in the central nervous system. You can call this "learning" if you like. However, the important thing is that total behaviour is on a basis of patterns of motor activity which are almost certainly inherited. Modifications of such patterns of motor behaviour can occur as the result of experience and they can be modified by the sensory feed-back mechanism. The sensory feed-back mechanism in the organism is not sufficiently complicated to permit of the learning of the patterns of movement.

With regard to the "th", it must be realized that in the articulation of any language acceptable sounds may be produced in a variety of ways. For instance, continental people can produce a very acceptable "th" in a way that English people do not. It sounds all right, however, and is acceptable. The way they produce it is undoubtedly related to their different morphological features.

On Miss Clinch's question about bimaxillary proclination, Professor Ballard did not agree that it is really due to skeletal form. In a previous paper he had pointed out that observation on cases through lateral skull radiographs had indicated quite clearly that one cannot reduce a bimaxillary proclination by more than about five degrees of change of axial inclination of the incisors. In another paper he had pointed out that the tongue in its adaptive behaviour appears to come instinctively forward against the labial segments and, as it were, puts them, through the physiological plasticity of the alveolar bone, against the lips. The morphological features of the lips do not change and therefore the axial inclination of the labial segment cannot change significantly. Miss Clinch had also asked about pain with cross-bites. One very rarely sees pain with a complete cross-bite with a left or right lateral displacement. The types of cases which present with pain are those with minute displacements from a centric path of closure. Sometimes the displacement is so slight that it cannot be seen clinically. However, if one manages to find the initial contact and grinds it away, the patient immediately remarks that he or she feels more comfortable, and the pain is likely to disappear overnight. In other words, it is the minor degree of displacement which might produce the muscle spasm.

With regard to the question of bringing conscious effort into the change of posture and behaviour, Professor Ballard said he had stressed in the paper that he does not believe that this is a sound approach. Conscious effort can induce postures and patterns of behaviour which are physiologically uneconomical and therefore they cannot be maintained as a subconscious habit. Permanent changes have to occur quite subconsciously and instinctively as orthodontic treatment is proceeding.

On the question about artificial dentures, the simplest answer might be that the prosthetist knows nothing about soft-tissue morphology. However, it must be conceded that in fact they have a much more difficult problem than the orthodontist. As soon as an individual loses all his or her teeth and also a bulk of alveolar bone, then adaptive behaviour occurs immediately. The individual may overclose in order to make good the deficiency of bulk. A considerable amount of research is required on these problems.

LONG-TERM ORTHODONTIC RESULTS

RECORDED BY CINEPHOTOGRAPHY

By **W. J. TULLEY**, B.D.S., F.D.S., D.Orth. R.C.S.
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THE film material which illustrates this short paper is a follow-up of earlier cine films which were taken in the Upper Respiratory Researeh Unit at Guy's Hospital between 1949 and 1954. This Unit was set up by Mr. E. Gwynne-Evans and myself, under the aegis of Mr. R. E. Rix and the late Professor Whillis. It followed the general pattern of the Tite Street Clinic where Professor Ballard was working with Mr. E. Gwynne-Evans.

The object of the Tite Street Clinie was to examine a large number of patients who were attending for routine E.N.T. examination, and this work has been fully reported (Ballard and Gwynne-Evans, 1947; Leeeh, 1958). Our Unit was designed to make a more detailed cine-photographic study of a smaller group of patients with speeeh, E.N.T., orthodontie, and general feeding problems.

I should like briefly to review some of the early work on the orofacial museulature in order to put our present-day views into perspeetive.

Rix (1946, 1948) described the signifieance of the atypical swallowing aetion whieh, at that time, he attributed to immaturity of behaviour of the orofacial musculature, possibly engendered by upper respiratory embarrassment. Ballard and Gwynne-Evans (1947) originally attributed this to immature patterns of behaviour, and set out to see whether this behaviour could be ehanged by exercises or applianee therapy, and we earried out similar clinieal trials. These elinical trials resulted in the publishing of work on the immutability of behaviour and its innate origin (Ballard, 1955, 1957). This brought a spate of protests and critieism from many elinieians. However, these views have moderated over the past few years and the significanee of adaptive modifieations and habit activities has been put in perspeetive (Ballard, 1962).

In a paper entitled "Clinieal Types" Gwynne-Evans and Tulley (1956) plaeed eonsiderable aecent on morphologieal features of the soft and hard tissues. Many interesting points were brought up in the diseussion and I would like to bring one or two of these faets to your notiee.

Rix pointed out that one of the weaknesses of typing cases aeeording to morphology in an established permanent dentition was that this masked what the aetual behaviour of the soft tissues was like at the time of eruption of the permanent ineisors. He said that the morphology of the dentition could lead to errors in assessing the signifieance of behaviour. He also pointed out that a tongue thrust did not necessarily mean that the behaviour was basically atypical.

In the same diseussion, Ballard stressed the importance of not labelling all tooth-apart swallows as atypieal, and he distinguished between habit aetivities which disappeared when the teeth were repositioned, and other forms of behaviour, whieh eould be described as "endogenous" or innate.

Personally, I do not think we were too far out in placing the emphasis on the morphology of the hard and soft tissues. So many of the activities whieh were labelled "atypical behaviour of the soft tissues" have been shown to be primarily adaptive modifieations, reflexly established, beeause of abnormal morphology, either due to abnormal dental base relationship, or to the shape and size of the soft tissues, or both. Ballard (1962) has pointed out that one form of adaptive modification may replaee another, following orthodontic treatment, provided it is as physiologieally economieal. This is partieularly true of lip position in relation to the upper incisors. (*Fig.* 1.)

It beeame quite elear to me when I discussed these problems with eolleagues in the United

Given at the Country Meeting held at Bournemouth on May 5, 1961.

States that they had over-emphasized the habit activities (Tulley, 1956). Some fully appreciated the significance of the shape and size of the hard and soft tissues, but among the younger orthodontists there was a very optimistic trend. We have tended to err on the side of pessimism. We need to know more about superimposed conscious, and sometimes unconscious, modifications in behaviour that take place in early adult life, which may overlay some of the truly adverse morphological and functional factors, and which some authorities maintain can be achieved only by exercises. We have found changes to occur naturally, and I strongly condemn those authorities who preach that functional training and attention to early feeding habits are likely to have any significant influence on fundamentally abnormal behaviour. I believe that there is only a relatively small proportion of cases where we need to be *really* pessimistic in our prognosis.

I would like to show some cases which have been followed up and recalled in their late teens, and to comment on them. They cannot all be said to show perfect results, but they illustrate some of the problems of skeletal and soft-tissue morphology, habit behaviours, and more innate behaviour. There has been a change in filming technique over the years because we have been conscious of the need to get as natural a picture as possible. Some of the early shots have been criticized as giving an artificial picture, but I believe that the evidence is valid.

Fig. 1.—Patient at 10, 12, and 19 years of age. Class II, division 2 malocclusion treated by extraction of $\underline{4|4}$, followed by retraction of $\underline{3|3}$, and then $\underline{21|12}$. Note the change in general features. She has acquired a new lip seal with her lower lip high up on the labial surface of the upper incisors, which now remain stable in this new environment.

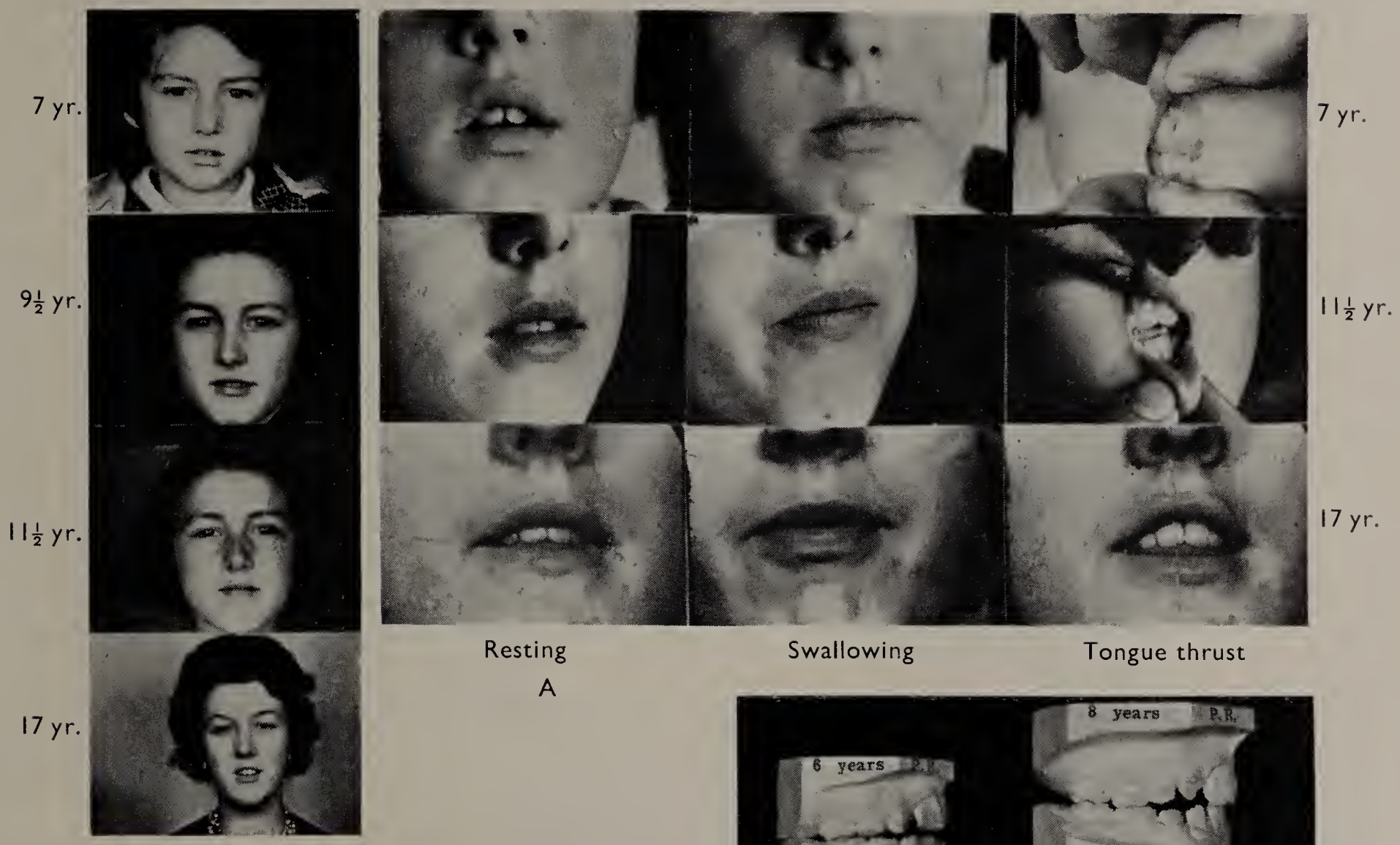
Unfortunately, it has not been possible to publish a fully comprehensive series of extracted frames to illustrate all the points made.

CASE REPORTS

P. R. (*Fig.* 2).—The patient was seen at the age of 6 years. She had a Class I malocclusion, small crowded arches, and a tendency to bilateral cross-bite—there was also a slight anterior open bite. Her lips were not sealed at rest and the oral fissure was extremely small. In swallowing, the tongue spread between the teeth to contact the lower lip and there was considerable circumoral contraction. There was a high Frankfort–mandibular-plane angle and a Skeletal 1 relationship. Her speech showed a slight lisp.

The crowding was treated by serial extraction and removable appliances were used to aline the incisors. She did not co-operate well with the treatment, and at the age of 11 years there was slight residual premolar spacing and some imbrication of the lower incisors. When she was recalled at 17 years of age, the anterior open bite was still present and there was still a tendency to bilateral cross-bite. Her lips were still "incompetent", and the tongue spread between the incisors in swallowing and in speech. There has been no fundamental change in the behaviour patterns, but there is no doubt that she has benefited from the decongesting of her arches. Skeletal and soft-tissue morphological factors and the tongue thrust placed definite limitations on the result.

E. S. (*Fig.* 3).—This patient was seen when she was 5 years of age. She had a Class II, division 1 malocclusion



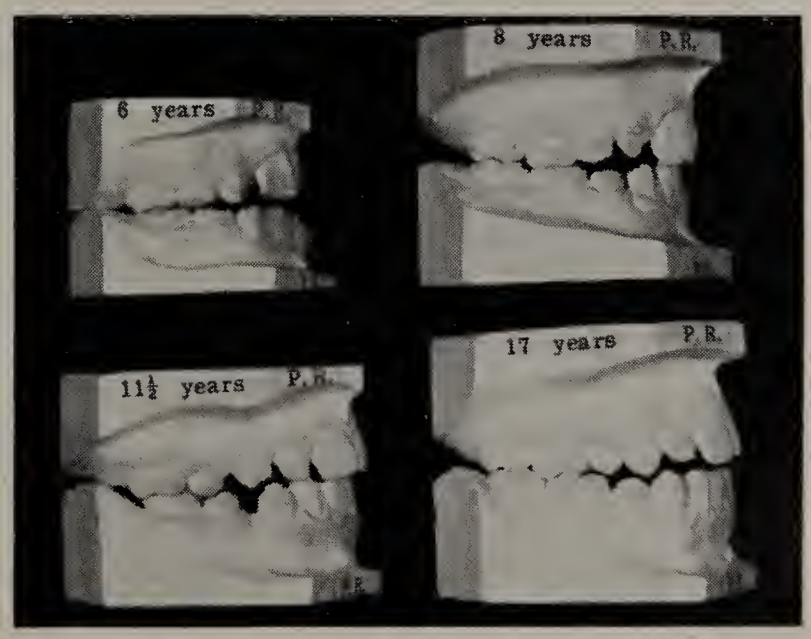
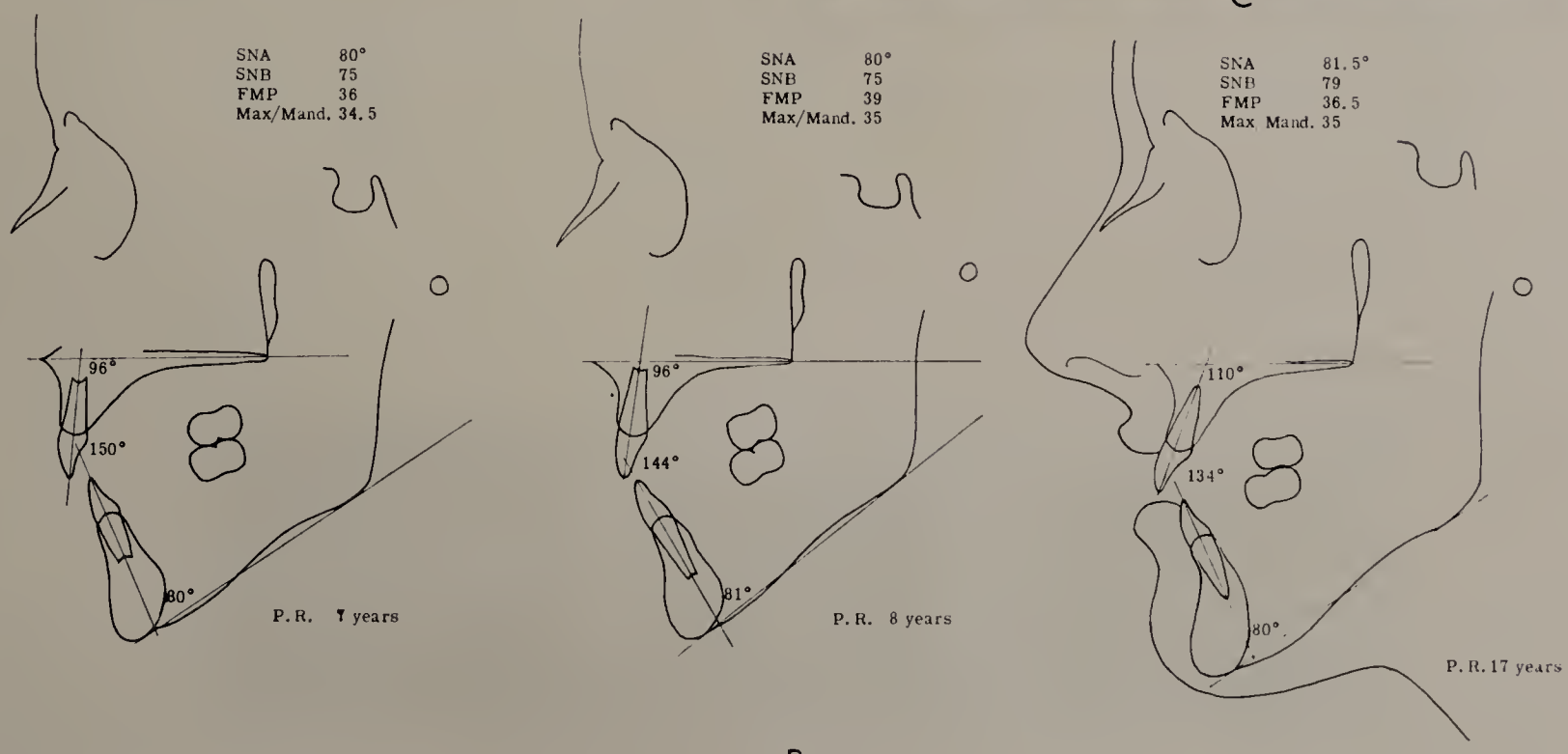
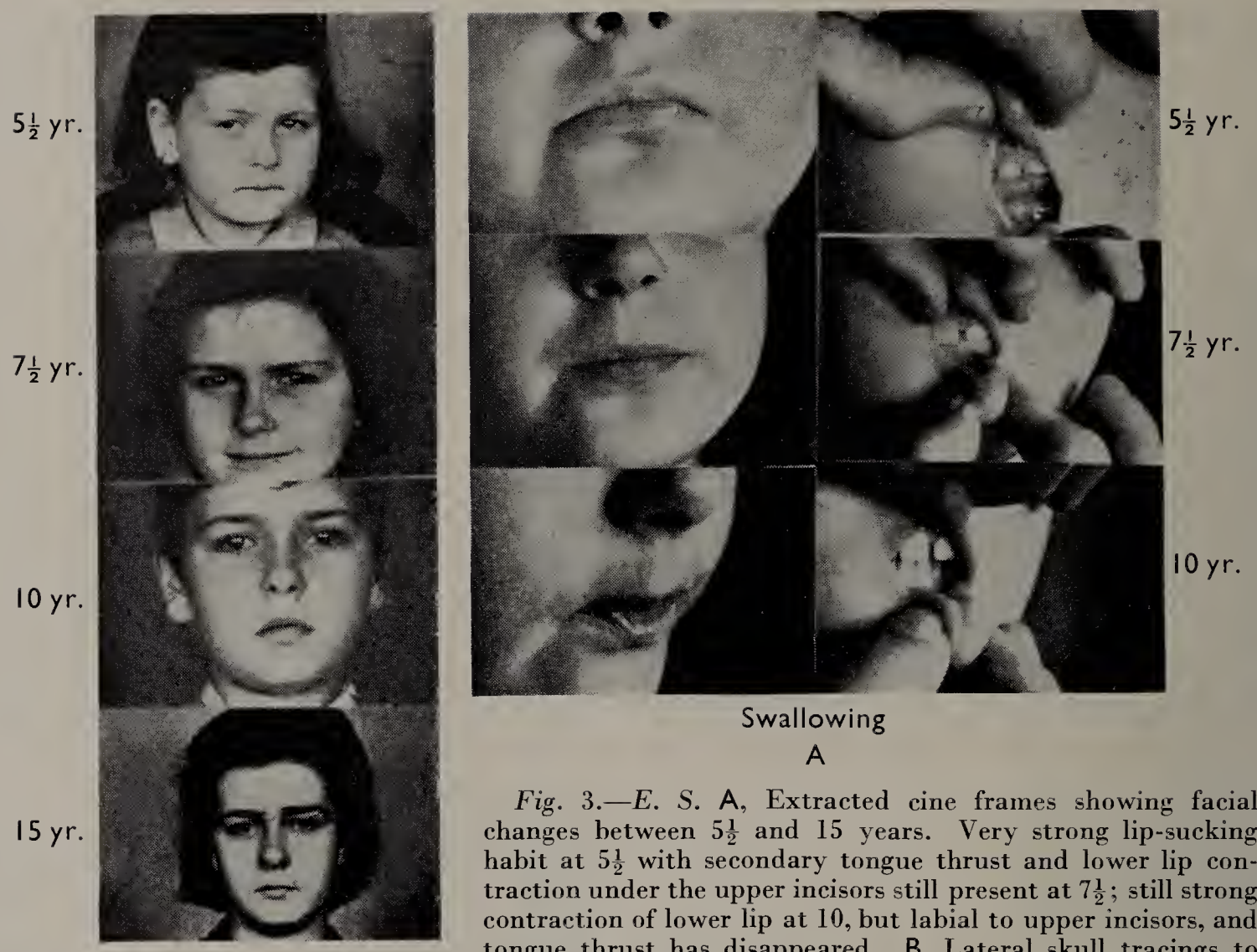


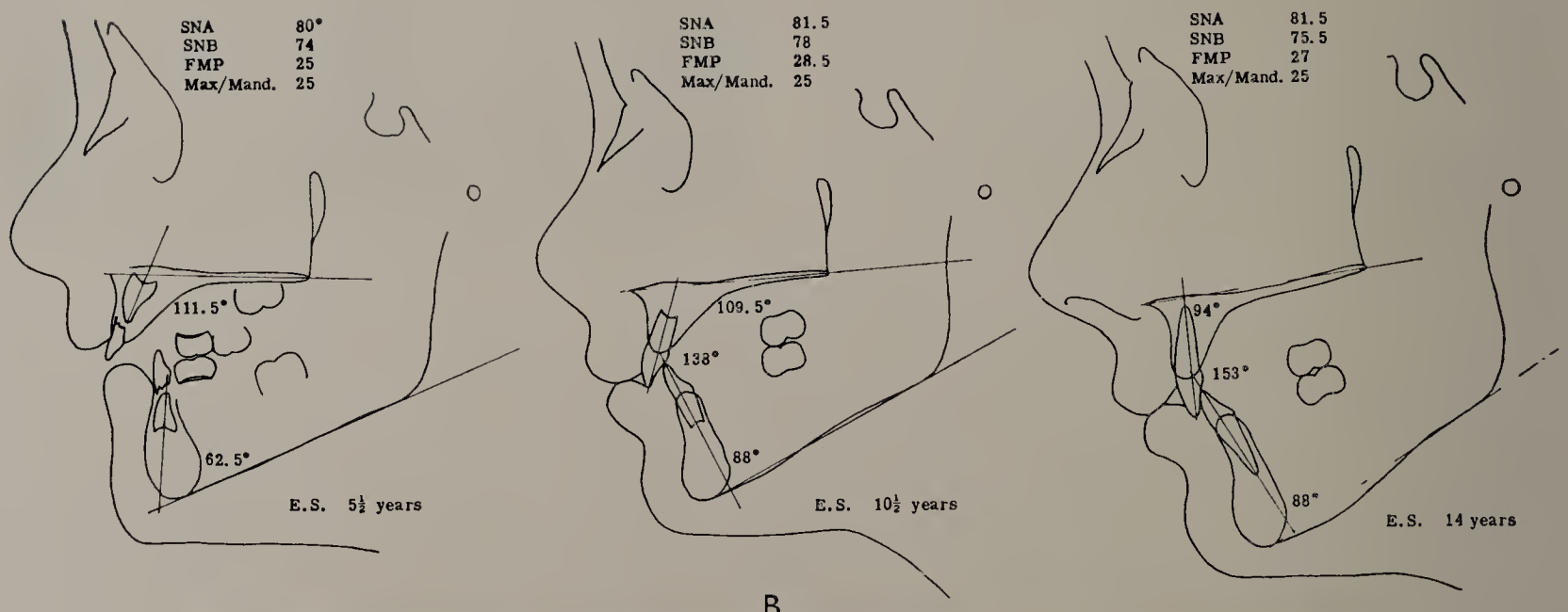
Fig. 2.—*P. R.* A, Extracted cine frames showing facial changes between 7 and 17 years. Note that the lips are still "incompetent" to effect an anterior oral seal at rest. Active lip contraction is seen in swallowing, and there is still a tongue thrust. B, Lateral skull tracings at 7 years, 8 years, and 17 years. Note high Frankfort–mandibular-plane angle. C, Models showing serial extractions allowing lateral incisors to erupt into the arch, but with persistence of the open bite.





A

Fig. 3.—*E. S.* A, Extracted cine frames showing facial changes between 5½ and 15 years. Very strong lip-sucking habit at 5½ with secondary tongue thrust and lower lip contraction under the upper incisors still present at 7½; still strong contraction of lower lip at 10, but labial to upper incisors, and tongue thrust has disappeared. B, Lateral skull tracings to show upper incisors remaining stable in retracted position, retained by lower lip; no interference from tongue. C, Models at 5½ years when lip-sucking action is strong, and at 10 years and 15 years of age.



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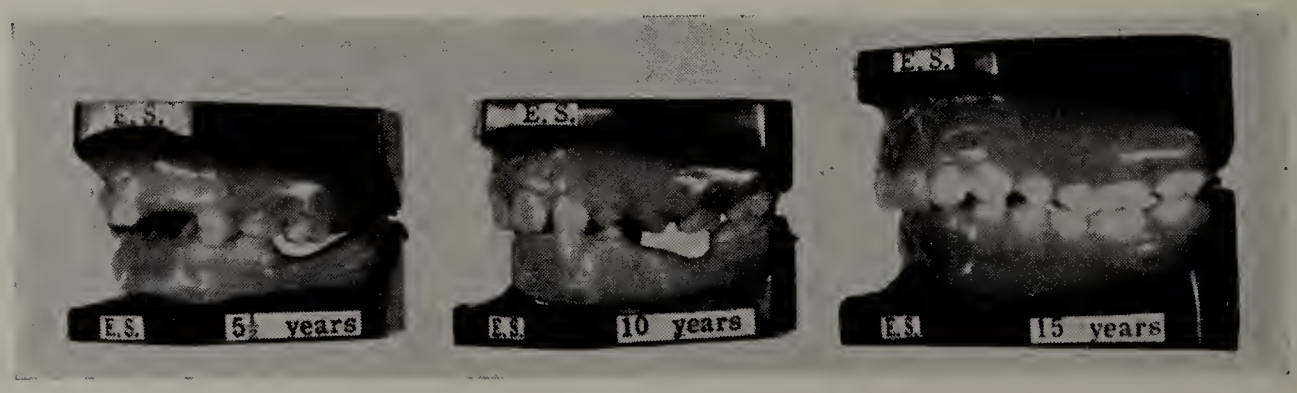


C

in the deciduous dentition and a Skeletal 2 jaw relationship. There was a very marked lip-sucking habit. In swallowing, the lower lip was indrawn to meet the thrust of the tongue, which was merely a secondary phenomenon. She was given an Andresen appliance to wear, which guided the permanent upper incisors palatally on eruption. This appliance was continued until upper permanent incisors were retained by the lower lip, when it was discontinued. She has been without an appliance now for 4 years. She had an underlying lip morphology of a Class II, division 2 type with a superimposed habit of lip sucking. The lower lip retained the upper incisors without active appliance retention.

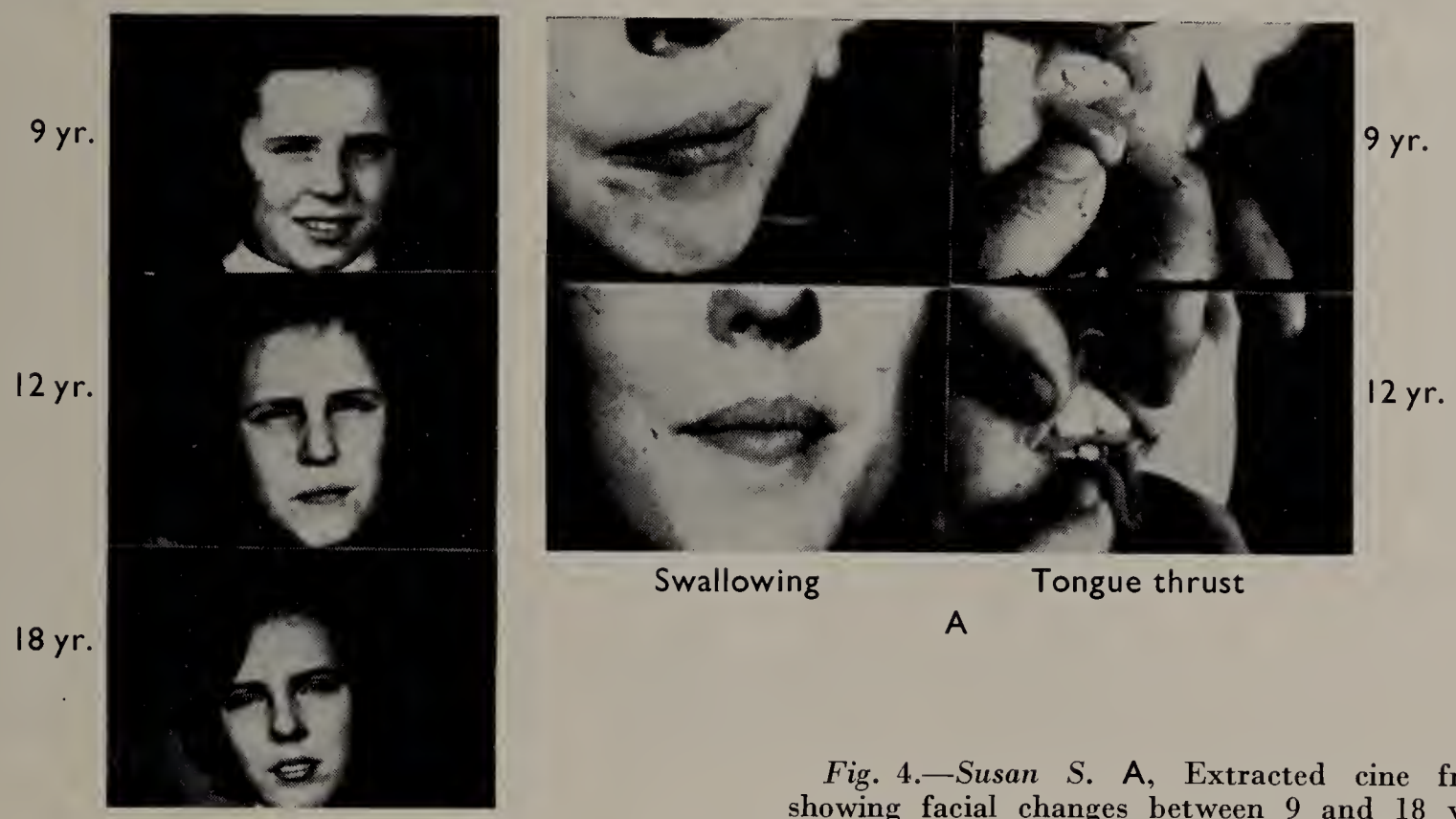


Fig. 4.—*Susan S.* A, Extracted cine frames showing facial changes between 9 and 18 years. Note that the lips are still "incompetent", but lower lip can be brought up on to the labial surface of upper incisors and they have remained stable. The tongue thrust which was present during swallowing at 9 years and 12 years was not present at 18 years. B, Lateral skull tracings showing overretraction of upper incisors which relapsed to the more stable position by 18 years. The open bite has been closed, as the tongue thrust was only a secondary phenomenon. There has been a slight reduction in lower incisor angulation. C, Models at $8\frac{1}{2}$ and 18 years.

Susan S. (*Fig.* 4).—This patient had a Class II, division 1 malocclusion on a Skeletal 2 dental base, and a

high Frankfort–mandibular-plane angle. She sucked her thumb and had a secondary tongue thrust through the anterior open bite. Her lips were "incompetent" and there was a marked contraction of the lower lip to effect an anterior oral seal in swallowing. She was first seen at the age of 7 years and treatment with the Andresen appliance was attempted for one year, with little success.

Treatment was then changed to the extraction of $\underline{5|5}$ and retraction of the anterior segment to a position where the lower lip would help to control the teeth. She was recalled at 18 years and there had been, as we expected, some relapse of the upper incisors to a more æsthetic angulation, but there is no evidence of persistent tongue thrust. The lower incisors show marked imbrication despite the fact that $\overline{5|}$ was extruded from the arch and extracted. This patient shows a pleasing æsthetic result. In retrospect $\overline{4|4}$ could well have been extracted in this case.

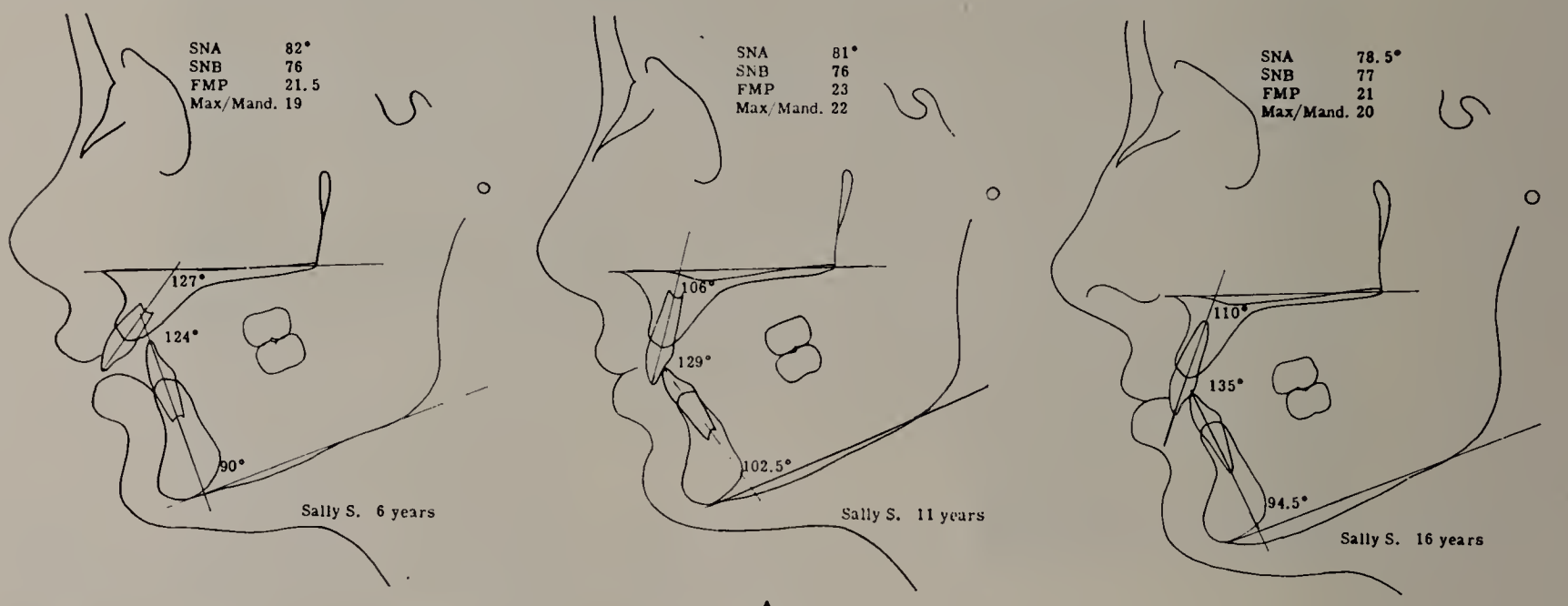


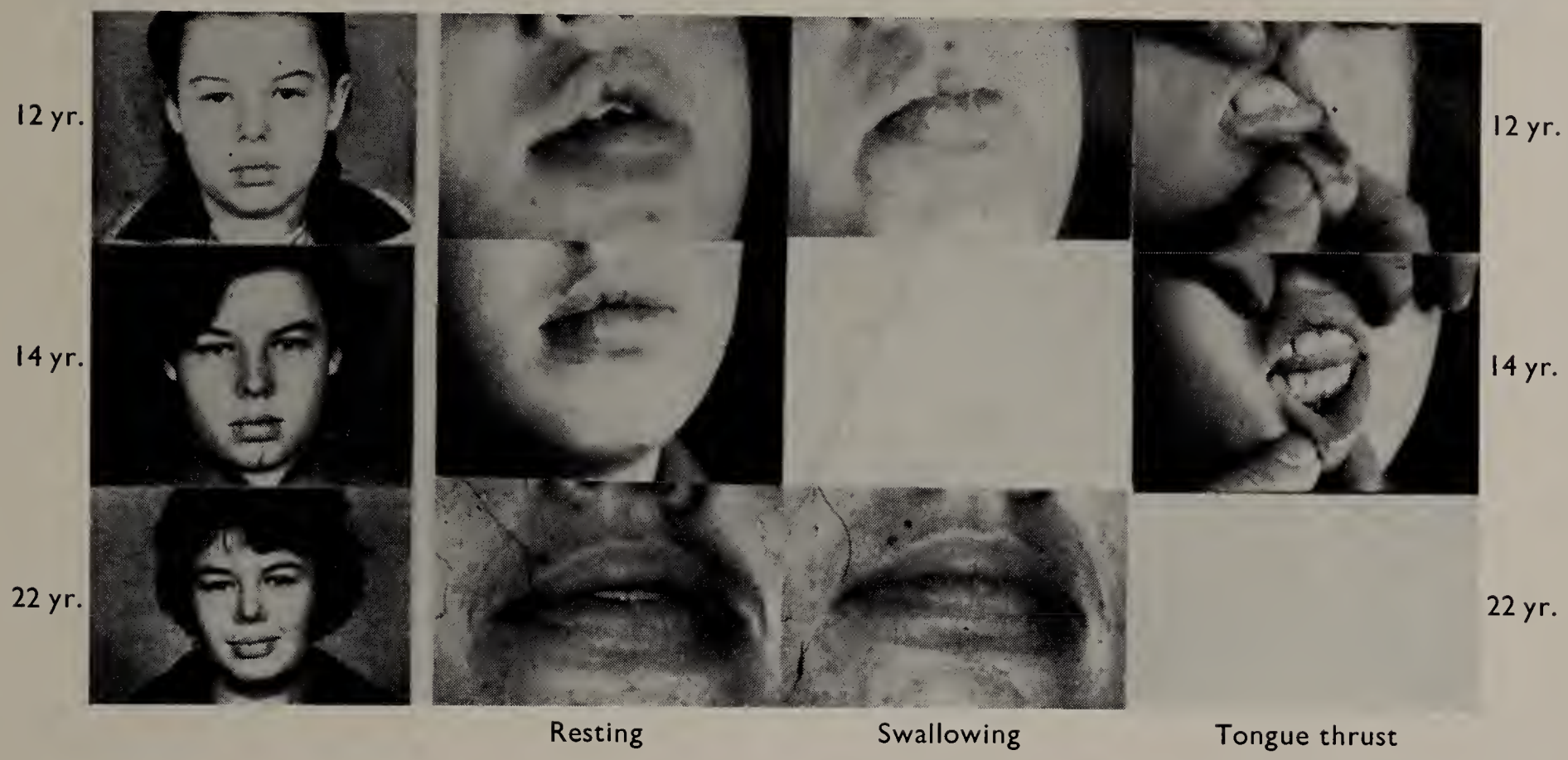
Fig. 5.—*Sally S.* A, Tracings of a Class II, division 1 malocclusion treated by Andresen appliance. Note slight relapse of upper incisors to stable position; lower incisors were proclined by the appliance but did not relapse to original inclination; note that there was no tongue thrust in this case. B, Models at $7\frac{1}{2}$, 9, 11, and 16 years; submerged $\overline{E|E}$ re-erupted into occlusion; $\overline{5|5}$ missing.

Sally S. (*Fig.* 5).—This patient was seen at 6 years of age. She had a Class II, division 1 malocclusion and a mild Skeletal 2 dental base. There was a habit contraction of the lower lip under the erupting upper incisors. No secondary forward movement of the tongue could be demonstrated. In view of the marked spacing in both arches it was decided to use the Andresen appliance, and marked improvement in the incisor relationship was established within eighteen months. There was some reciprocal proclination of the lower incisors with the inevitable relapse to the stable position shown in the last X-ray tracings, where the inclinations of the teeth approximate to the average with a mild Skeletal 2 dental base relationship. It would have been quite wrong to have extracted teeth in the upper arch in this case in view of the midline diastema. Prolonged retention was maintained by the patient knowing that she had a tendency to suck in the lower lip.

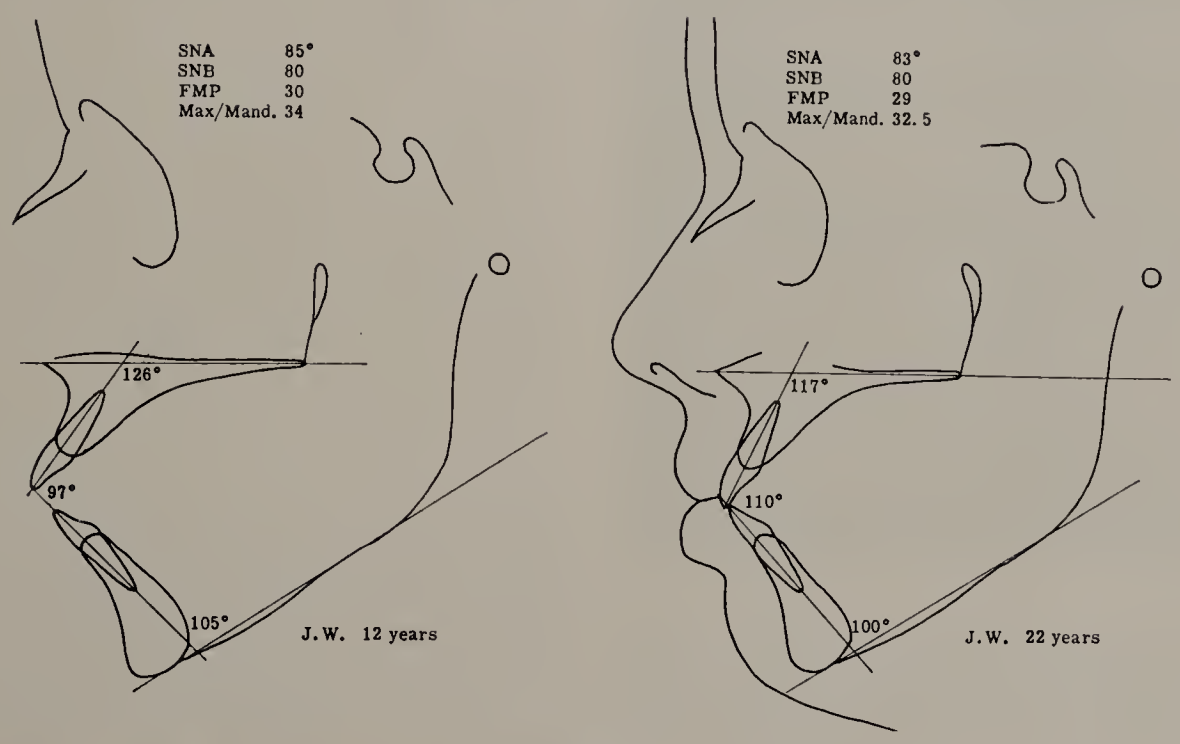
J. W. (*Fig.* 6).—This patient was seen when she was 12 years of age. She had a bimaxillary proclination with thick, everted, "incompetent" lips and a marked thrust of the tongue. The tongue was also obviously quite large. The relationship of the dental bases was Skeletal 1 with a tendency to bimaxillary protrusion. At this time monoblocs were being used as a form of lingual screen, but we realized the prognosis was too poor, and so the monobloc was worn for only a few months. An improvement in tongue interference and more constant lip closure were seen at the age of 14 years.

The patient was recalled at the age of 22, and she had married. The same basic posture and behaviour of soft

tissues can be seen. There has been a reduction in the incisor proclination, with increasing conscious control of overclosure. The upper incisors were already proclined to 125° and the tongue spread forward between the teeth in



A



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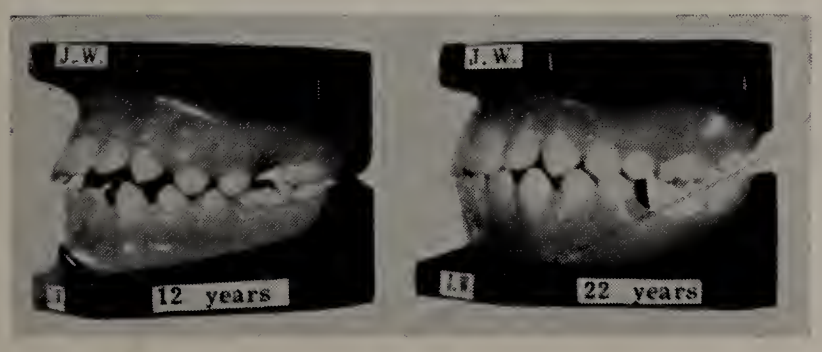


C

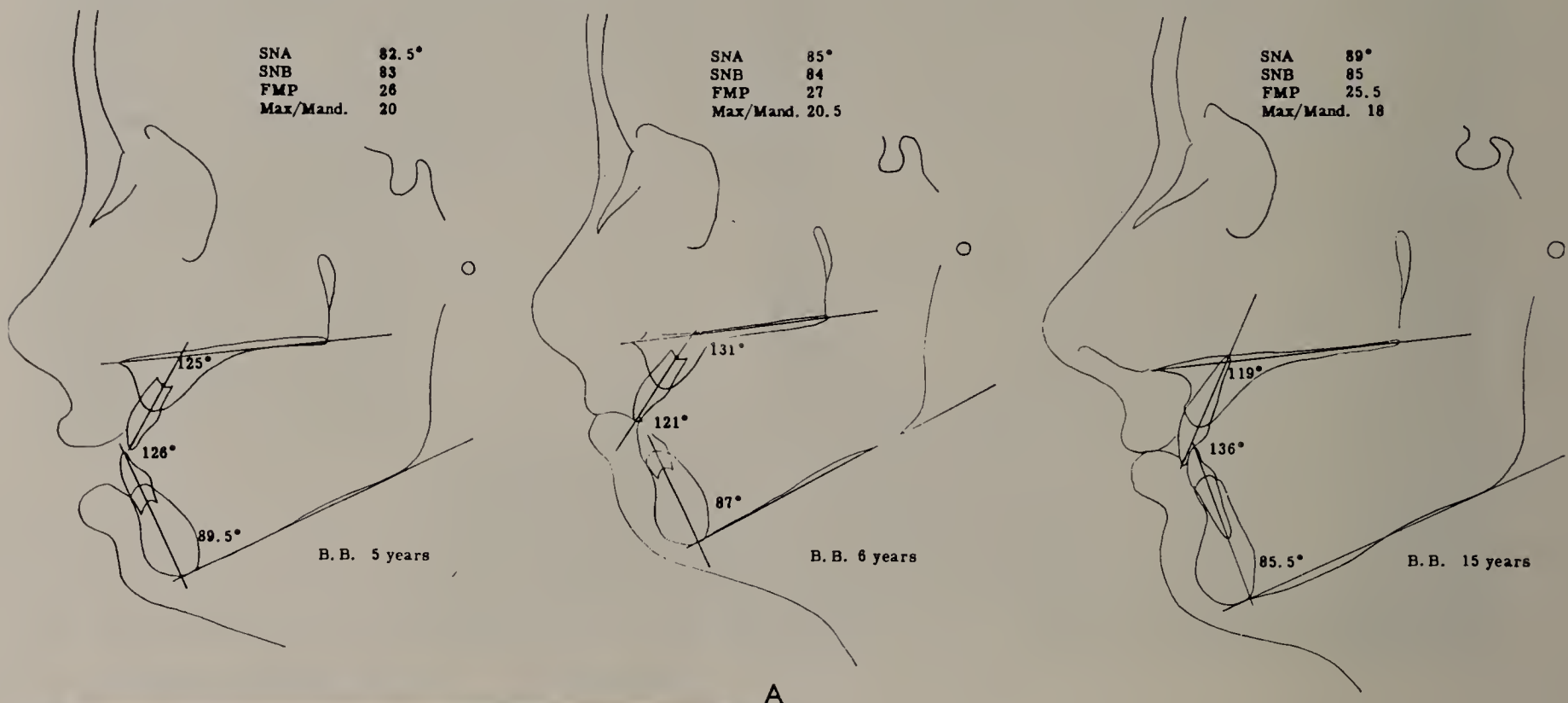
Fig. 6.—*J. W.* A, Extracted cine frames showing facial changes between 12 and 22 years. Notc lips still flaccid and incompetent requiring activc contraction in swallowing; tongue thrust still marked. B, Lateral skull tracings at 12 and 22 years of age showing natural reduction in open bite and inclination of upper and lower incisors without trcatment C, Models at 12 years and 22 years.

lips, and there has been some relative rcductioni n tongue size so that a near edge-to-edge bite has been obtained.

B. B. (*Fig.* 7).—This boy was seen at 5½ years of age. He had a Class III malocclusion with some degrec of the reverse manncr to that in Class II, division 1, tending to seal with a rather tight upper lip. He had a slight lisp.

Treatment consisted of a simple removable appliance to push the upper labial segment forward. $\underline{|2}$ was missing

and $\underline{|3}$ was allowed to drift mesially. No elaborate bridge-work was planned. He had very poor quality teeth and unfortunately $\overline{6|6}$ had to be extracted. The interesting features of the follow-up of this case show that



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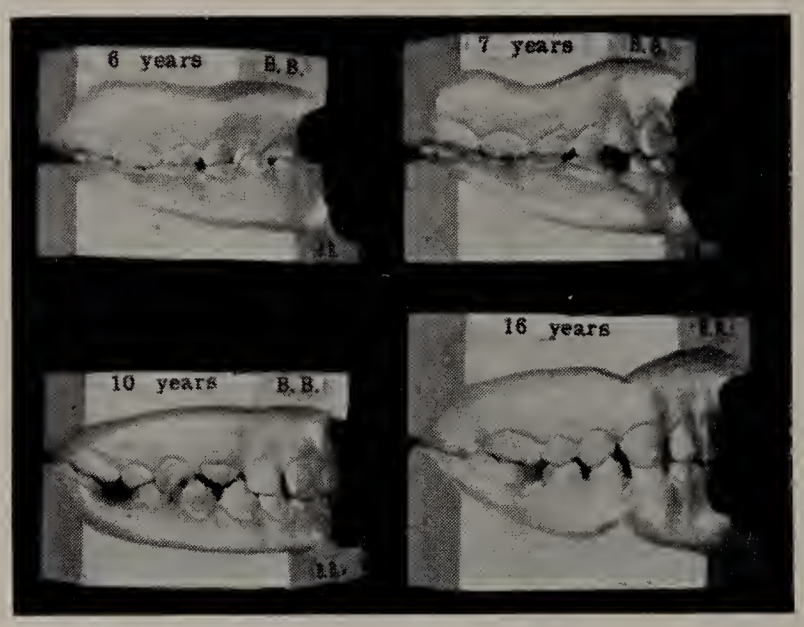

B

Fig. 7.—*B. B.* A, Lateral skull tracings of case at 5 years, 6 years, and 15 years. Note considerable reduction in inclination of upper incisors between 6 years and 15 years. B, Models to show improved incisor relationship; case mutilated by enforced extraction of $\overline{6|6}$.

despite the initial gross proclination of the upper incisors, there has been a considerable diminution in their inclination. The tongue thrust, which was a secondary feature, has disappeared, but his teeth are not placed together in swallowing.

It is obviously not an economic proposition to carry out a large longitudinal study by this method, but we have found some of this material to be invaluable for teaching, as the student can appreciate the long-term results. We are now concentrating on serial cine films of those cases with a very poor prognosis with persistent tongue thrusts.

Acknowledgements.—I would like to thank Mr. Rix and Mr. Pringle for their encouragement in this work, and especially Mr. E. Gwynne-Evans for the initiation of this cine work (he personally took all the early films); Mr. Jones of the Dental Photographic Department for the recent cinephotography; Mr. Colwell for the preparation of the models; Mrs. Rawlins for the tracings and secretarial assistance, and, lastly, those patients who have given up time from their work in various parts of the country to come back and be refilmed. I hope to have the opportunity of filming some of their children in the not-too-distant future.

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DISCUSSION

Professor C. F. Ballard said that it suddenly dawned on him how much was owed to Mr. Gwynne-Evans. Mr. Gwynne-Evans had brought cinephotography into their work; Mr. Tulley would agree with that. He remembered Mr. Gwynne-Evans saying, "We have got to look at these films time and time again. We have got to go back to them." He now felt convinced that if they had not had cinephotography over the last 15 years, they would not be thinking as they were now. They would still be muddle-headed over their attitude to soft-tissue morphology. They could still go back and look at the films and learn things; they suddenly made little problems completely clear. Mr. Tulley was doing very valuable work indeed.

There was little he could say except to emphasize what Mr. Tulley had said. With regard to the first case, there were one or two things that interested him with regard to the lisp. It was a low tongue behaviour type, and in such a case the way their speech therapist had assisted patients to get rid of a lisp was by teaching them to put the tip of the tongue against the lower incisor teeth. That was found not to be quite enough. If there was still an over-jet present, they had to be taught to posture the mandible forward a fraction to enable the blade of the tongue to contact the roof of the mouth above the upper incisor. Speech therapists might try to teach people to talk without a lisp and after years of therapy they might not succeed. However, on the basis of knowing the easiest way for the patient to use his tongue they might succeed in a matter of 10 minutes. If they tried to teach them according to the text-books they would fail completely in many cases.

He was interested in the first case also because it showed very well indeed how lower premolar spaces closed up very successfully without multiband appliances.

The second case also interested him because he believed it demonstrated very well the type of case he had in mind that fitted into one of his pigeon-holes. It was a type which was basically Class II, division 2, but quite possibly had a post-normality of the dental base which was greater than usual with Class II, division 2, and instead of the upper incisors developing behind the lower lip, they were in front. When it was treated, it turned into a Class II, division 2. He did not think Mr. Tulley was wrong to leave the cusp relationship as it was in the buccal segment, because if you had an excessive incisor overbite in the incisor region with alined upper and lower incisors there would be spacing in the upper arch.

He gathered that Mr. Tulley thought that the best place to wear a monobloc appliance was in the pocket. Was it working in some way akin to the "black box"?

Mr. H. G. Watkin said that in all the cases of protrusion, particularly bimaxillary protrusion, where the teeth were spaced, one had to reduce the size of the tongue. It was an easy operation and had always been successful.

Mr. A. G. Huddart thanked Mr. Tulley for an extremely interesting paper. He had been going to bring up the question of bimaxillary protrusion himself, but Mr. Watkin had already mentioned it earlier in the discussion.

Bimaxillary protrusion cases were very difficult to treat, but he had taken a certain amount of comfort from Miss Clinch's remarks in an earlier discussion.

Perhaps her case was the exception that proved the rule, but he would like to know, in a series of cases, whether it was considered justifiable to do a resection of part of the tongue. It seemed a sensible thing to do if speech was not adversely affected.

Mr. J. C. Ritchie congratulated Mr. Tulley on his most interesting paper. One point he wished to mention was in connexion with the first case shown, and put forward his remarks merely as a suggestion. It seemed to him that in a case of that kind, with a high Frankfort–mandibular-plane angle, there might be considerable grinding of the cusps to improve the articulation. In his experience, a grinding of 1 mm. gave approximately 3 mm. of closing in the anterior region. It might be one of those cases where an anterior open bite could be completely closed in that way.

Mr. S. Haynes said that at the end of Mr. Tulley's paper he had the impression that most of the cases had competent lips after treatment, although the change was said to be consciously maintained.

Had Mr. Tulley done any electromyographic investigations to compare the electrical activity of the lip muscles before and after treatment?

Miss L. M. Clinch asked whether Mr. Tulley would agree that his cases were not the average run of cases that one saw in orthodontic practice every day? It seemed to her that it might be rather misleading if it was thought that they were. For example, she would have said that the first case was, very luckily for them, an uncommon type. They all knew that type of lisp case and wished it had gone somewhere else; but they were comparatively rare.

With regard to the second case, Mr. Tulley had eventually mentioned that she sucked her lower lip; that seemed to her an important point in the case. That sort of sucking was very difficult to treat; it was not an uncommon habit. It seemed to her that, listening all day, they must now start making a distinction between good habits and bad habits. The children seemed to start with bad habits and then they acquired good habits, but they were still called habits—behaviour habits. She thought it was about time that they realized that all the habits were not bad ones.

With regard to the bimaxillary protrusion case, the more that was said the more it seemed to her that the tongue was what was causing that, not the lips. She understood from what Professor Ballard had said that the lip morphology had produced bimaxillary protrusion. Would Mr. Tulley agree that the tongue was either the cause or at least the balancing factor?

In the pseudo-prenormal mandible case in which Mr. Tulley showed the deciduous incisors had corrected themselves, had he seen many cases like that, or would he agree that it was uncommon? She could show quite a few where the deciduous incisors had not corrected themselves, and she was therefore putting in a word for early treatment in these cases.

Mr. Tulley thanked Professor Ballard for emphasizing the fact that if it had not been for the originators of the work, they would not have had the material. Mr. Gwynne-Evans has turned his hobby to lasting scientific value. Mr. Rix had shown a film in 1946, and there was no doubt that, if it had not been for these pioneers, they would not have the records. However much one talked about those things, unless one had something to show in an animated way, people would not be convinced.

He agreed in the main with Professor Ballard, but he was a little worried about speech training. He thought Professor Ballard would agree that there was a question

of the auditory perception varying from one case to another. There were some children who were mentally dull, and it was difficult to try to re-educate tongue and lip through auditory perception or any other means.

The lisping problems were intriguing. In a book on the psychology of speech, there was a very pert saying, "a lisping lass is a kissable lass". Perhaps they should not always try to cure it!

He was pleased that Professor Ballard had commented on the closure of premolar spaces. Frankly, he himself did not have too much trouble closing them; it was the other way round in most cases. As Professor Ballard rightly pointed out, the fact that one had married was evidence of the fact that she was æsthetically acceptable, and perhaps he would shortly be able to film her first infant from early on.

With regard to the monobloc, he would not always condemn it to the pocket; it had its place, but it had to be watched as carefully as a multiband appliance. He was in favour of using a monobloc, but he did not think people should use it unless they had experience.

He had known what Mr. Watkin would say about the tongue; he could not himself honestly believe that they should use surgery in these cases. He did not think the æsthetics warranted it. He certainly would not let anyone do it to him or to his children, which was the criterion to apply. That answered Mr. Huddart as well.

Referring to Mr. Ritchie's comments on grinding, he did not think that, in the case with the high Frankfort–mandibular-plane angle, any improvement would be produced by grinding. He did not think it had any value.

In reply to Mr. Haynes on the electromyograph recordings, he had not done serial studies; people were doing those, and he was planning to do so. It was terribly important to have the right apparatus. The ordinary clinical apparatus was not suitable. You had to have very low noise level apparatus. They had one at Guy's, but it was difficult of access. The noise level had to be very low so that you could pick up the very slight contraction of the lips to compare with so-called normal cases. He thought it might be quite valuable.

He agreed with Miss Clinch that the selection of cases was not a cross-section of the average patients. Orthodontics would be a dull subject if they had average patients all the time. They could move teeth around and straighten up crowded arches. They got very good results, but it was in those cases where there were real problems that they came unstuck in their intention and their treatment planning.

He mentioned that the second child sucked her lip. There was a difference between those habits which were external; it might have been her thumb, but it was tacked on to a mandible.

The Americans used the word "habit" in too broad a sense. When they saw a child with the morphologically abnormally shaped lower lip and strap-like lip that Professor Ballard talked about, they called it a "mentalis" habit. The terms needed more correct definition.

He thought the tongue was a factor in bimaxillary protrusion, particularly the question of size of tongue. There were some tongues that acted in the way that Professor Ballard had described, and they were not really large. There were some tongues that were really large as well as acting in that way. Morphology and function had to be taken together.

With regard to the Class III case which was untreated and corrected itself, he agreed that that was not so very common, but he thought a high proportion of the infants they saw with Class III malocclusions had some postural element about them. He had put in an overlay plate preparatory to making an extra-oral anchorage appliance; he had sent the patient away for three weeks, and when he came back and took the plate out, it was corrected. He thought that orthodontists sometimes wasted a lot of time; he knew that was a very controversial issue.

Miss Clinch thanked Mr. Tulley and Professor Ballard for the paper and for opening the discussion.

CONGENITAL SUPRABULBAR PARESIS

By **D. F. GLASS**, L.D.S. R.C.S., D.D.O., R.F.P.S.
Plastic and Jaw Injuries Centre, Queen Victoria Hospital, East Grinstead

It is now generally accepted that soft-tissue behaviour plays a very important part in the aetiology of malocclusion, and that many malocclusions are directly attributable to unusual or atypical soft-tissue behaviour.

Fig. 1.—Mild paresis: the orbicularis oris cannot contract enough to whistle.

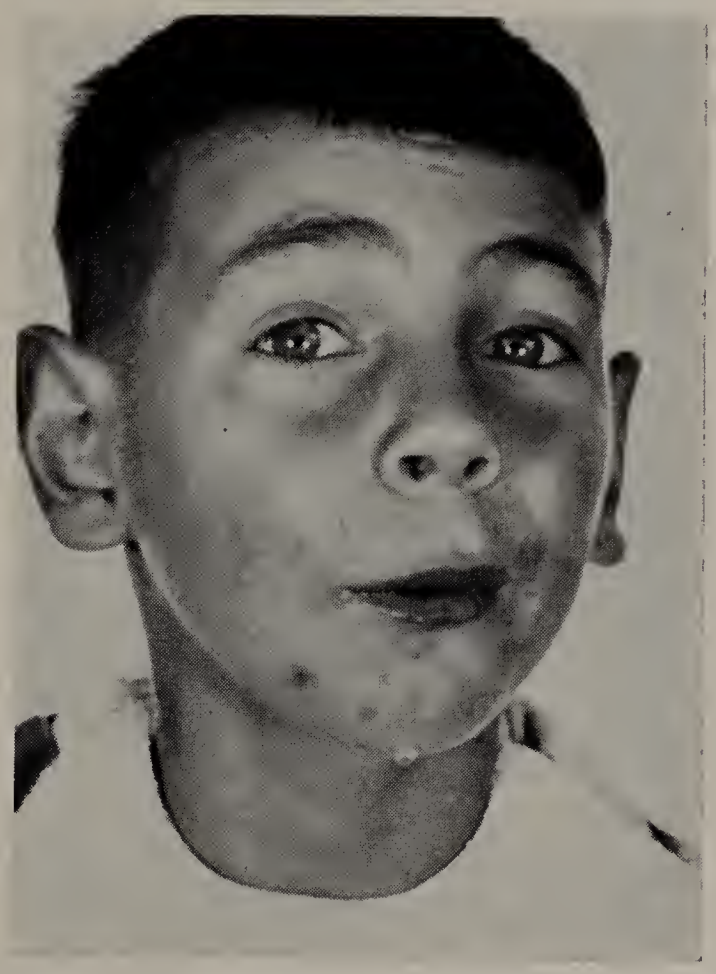


Fig. 2.—Severe paresis, showing very poor contraction of lips with usual dribbling.

Thus, complete or partial paralysis of the labio-glossopharyngeal muscles might be expected to produce interesting malocclusions.

The paralysis of these muscles was first properly described by Worster-Drought (1956) as a weakness or paralysis of all or some of the muscular structures which have their nerve-supply through the medulla or bulb, and affect the peripheral organs of speech and deglutition. He called it "congenital suprabulbar paresis", or "suprabulbar palsy", which fully describes the condition. Congenital, because it is present at birth; suprabulbar, in that the primary lesion is located in the motor pathway above the bulb or medulla; and paresis, to include a weakness as well as complete paralysis.

The muscles affected include all or some of the muscles of the lips, tongue, soft palate, and pharynx. The complete syndrome affects all the above muscles, while a mild type may affect only the pharynx and soft palate.

The typical features of the syndrome are as follows:—

The orbicularis cannot contract the lips enough to whistle or say "who" (*Figs.* 1, 2).

The jaw jerk is increased in intensity in this upper motor-neuron lesion, and is differentiated from lower motor lesions, such as poliomyelitis, in which the jaw jerk is absent.

The tongue lies between the lower teeth, and it may be difficult to protrude it (*Fig.* 3). If it can be protruded it rests on the lower incisor teeth, while the tip cannot be raised (*Fig.* 4). Owing to the inability to raise the

Given at the Country Meeting held at Bournemouth on May 6, 1961.

tongue to the roof of the mouth, the surface of the tongue is often covered with a greyish furred area which is easily removed by gentle brushing. This would appear to be epithelial debris which occurs on the tongue surface and would normally be removed by tongue movements during eating and swallowing.

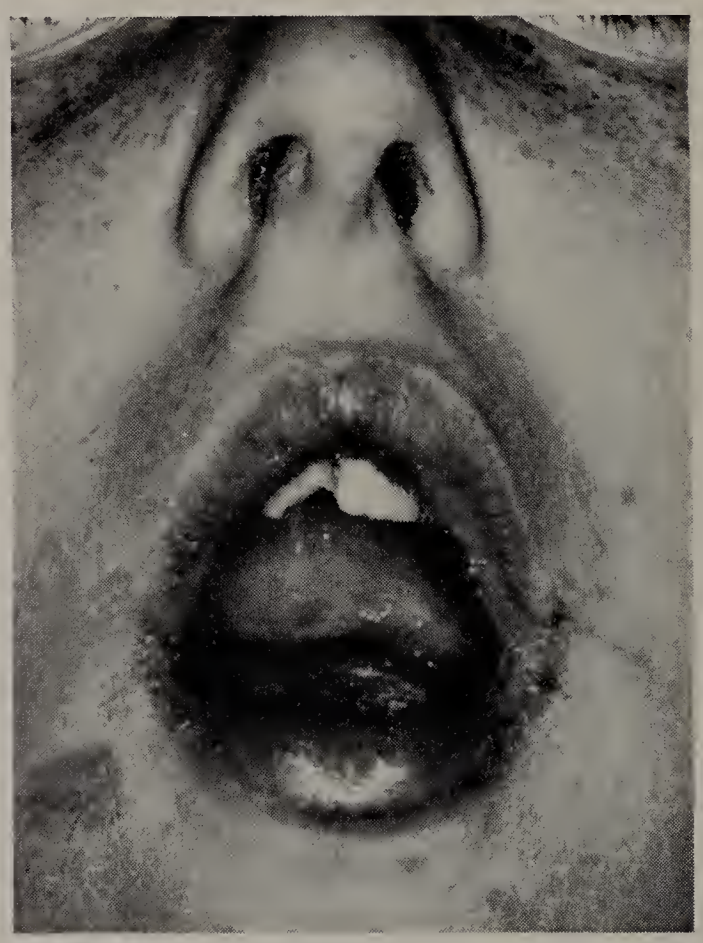


Fig. 3.—Severe paresis; the tongue cannot be protruded or raised from the floor of the mouth. The tongue surface is often covered with a greyish furred area.

The soft palate, owing to the defective functioning of the tensor palati and levator palati muscles, cannot be raised to meet the pharyngeal wall. Thus there is no separation of the nasal from the oral cavity during speech and deglutition. This lack of nasopharyngeal closure permits food and air to escape into the nose during eating and speaking, while the paresis of the pharyngeal muscles is made evident during swallowing.

The syndrome thus presents the following *functional problems*:—

Swallowing.—As would be expected, swallowing is greatly affected. The lack of lip closure, and lack of mobility of the tongue, prevent the initiation of the complex act of deglutition, and, in severe cases, normal swallowing is almost non-existent, the food and fluid being thrown back into the pharynx by tipping the head back. This type of throw-back swallowing is very similar to a bird drinking. Lack of tongue movement prevents the bolus of food from being pushed back past the soft palate, so that dry food presents a swallowing problem which is greatly assisted by swilling the food to the back of the pharynx

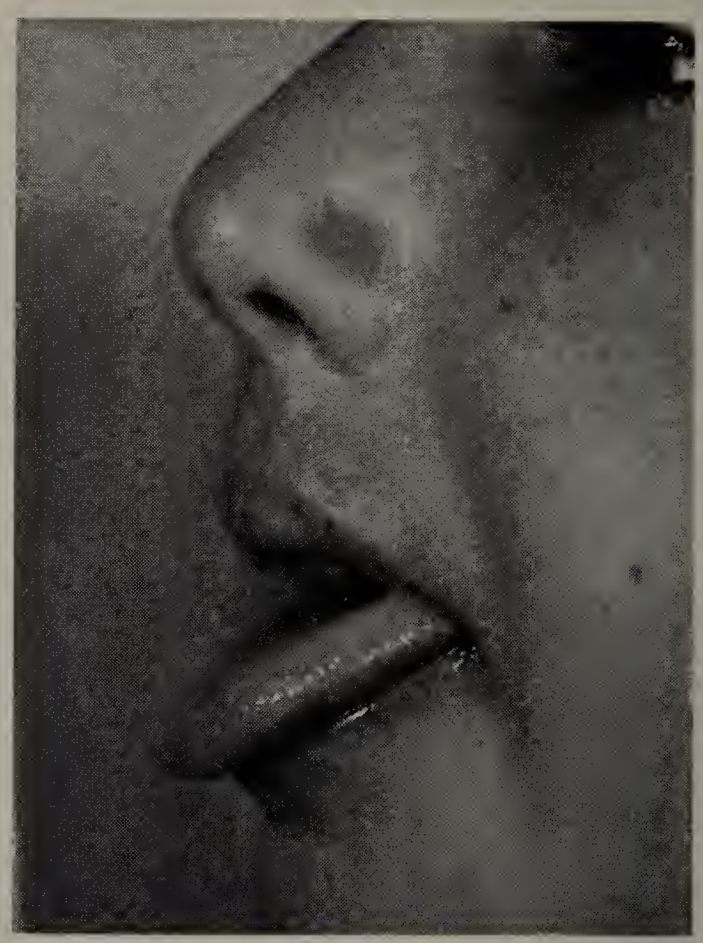


Fig. 4.—Inability to raise the tip of the tongue is a constant feature.

with water or tea. At the same time, the lack of palatopharyngeal seal allows the escape of food and fluids into the nose.

Speech.—Depending on the severity of the paresis, speech is accordingly affected, being completely unintelligible in severe cases. Inability to co-ordinate the lips interferes with labial sounds, "p", "b", "m", etc. The inability to lift the tongue to the position behind the upper incisors affects the "th" and "s" sounds. The paresis of the tongue prevents the elevation of its posterior third to contact the soft palate and posterior edge of the hard palate. This interferes with the formation of letters "g" and "k".

The soft palate paresis allows air to escape into the nose, producing rhinolalia, making such sounds as "s" and "g" difficult to say. Added to all this, the lack of finer co-ordinated movements of the muscles of the lips, tongue,

soft palate, and pharynx produces inarticulate speech known as dysarthria (Moore, Hudson-Smith, and Manning, 1957). In severe cases, speech is impossible, and all attempts are unintelligible to everyone except a trained speech therapist.

Dribbling.—Profuse dribbling is a common feature in many cases (*Figs.* 1 and 5), although there is no evidence of an increase in the amount of saliva secreted. This is due to the inability to swallow the normally secreted saliva, which, in many cases, drips out of the mouth continually. The pillows at night, and the clothes by day, are perpetually saturated, causing considerable embarrassment to the child, while the lips and chin are red and sore from constant dribbling. Wynn-Williams (1958) considers that the constant necessity to wipe the wet chin and lips develops into a habit similar to a nervous tic.

The dental condition varies considerably from case to case, but the more severe the paresis, the greater the effect on the dentition. In the mild cases the teeth do not show a high caries incidence, despite some lack of self-cleansing action from the labiolingual musculature. In some of the more severe cases, however, decalcification of the labial and lingual enamel is seen in all teeth of both jaws. Owing to the limited number of cases seen, it is difficult to know whether this decalcification is due to lack of the cleansing action of the muscles, the reduced salivation following submaxillary gland resection, or a combination of both.

From an orthodontic point of view these patients do not present the malocclusions which might be expected from such abnormal muscle behaviour. Although the lip-seal may be established the orbicularis oris does not function normally. The tongue with such limited movement and absence of the ability to swallow food and saliva would suggest dental derangements which we would expect to coincide with some of the causative factors of malocclusion in routine orthodontic practice. This, however, is not the case. The 7 cases under review all have well-developed upper and lower dental arches with teeth in good or reasonable occlusion:—5 were Angle Class I; 1 was Angle Class II, division 1; 1 was Angle Class II, division 2. There is no maxillary

Fig. 5.—Inability to swallow produces constant dribbling.

collapse which might be associated with an abnormal or atypical swallow, yet in this syndrome the swallowing mechanism is greatly restricted owing to the inability of the tongue to co-operate. However, despite the defective soft-tissue behaviour, the dental arrangements of both jaws were remarkably good throughout the cases seen (*Figs.* 5–10).

AETIOLOGY

The aetiology of this condition is undecided. Worster-Drought (1956) considers suprabulbar paresis is congenital and due to a developmental defect of the corticobulbar neurons. This is supported by the fact that there is a strong familial occurrence of the syndrome. Another suggested causative factor is respiratory difficulty at birth producing anoxia. This, however, has not been definitely established.

TREATMENT

This may be divided into surgical, dental, and speech therapy. The dribbling is best

treated by complete surgical removal of both submaxillary glands. (Moore, 1959; Grady, 1958). This greatly reduces the flow of saliva, and dribbling usually ceases or becomes much less marked. Irradiation of the salivary glands has been tried, but results of this procedure have been poor.

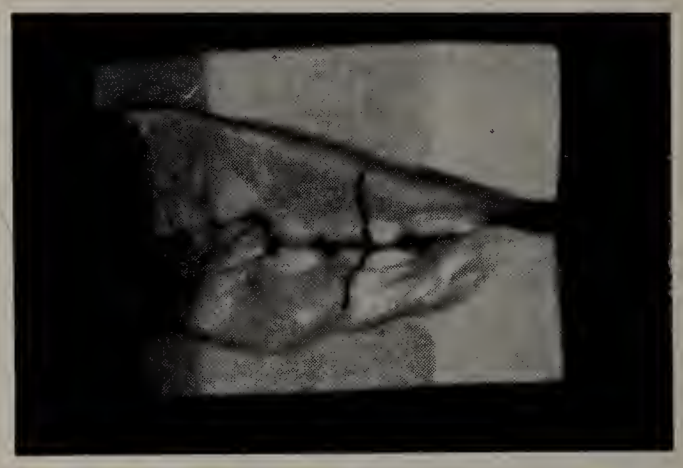


Fig. 6.—Models showing Class II, division 2 malocclusion, but with well-developed dental arches.

Speech has been greatly improved by pharyngoplasty. The object in this operation is to close the nasopharyngeal opening by uniting the inert soft palate to the posterior pharyngeal wall. Moore (1959) has recently devised a surgical operation which involves the introduction of muscles from the pharyngeal wall into the soft palate between the nasal and palatal mucosa, so that the muscle meets in the midline, and gives palatal movement similar to tensor and levator palati muscles.

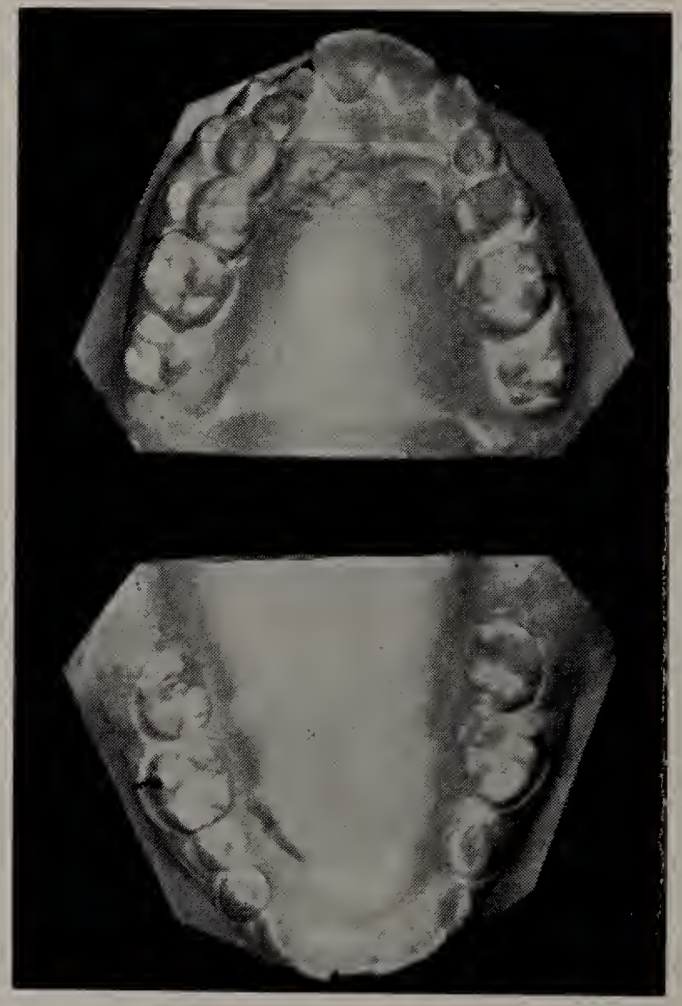
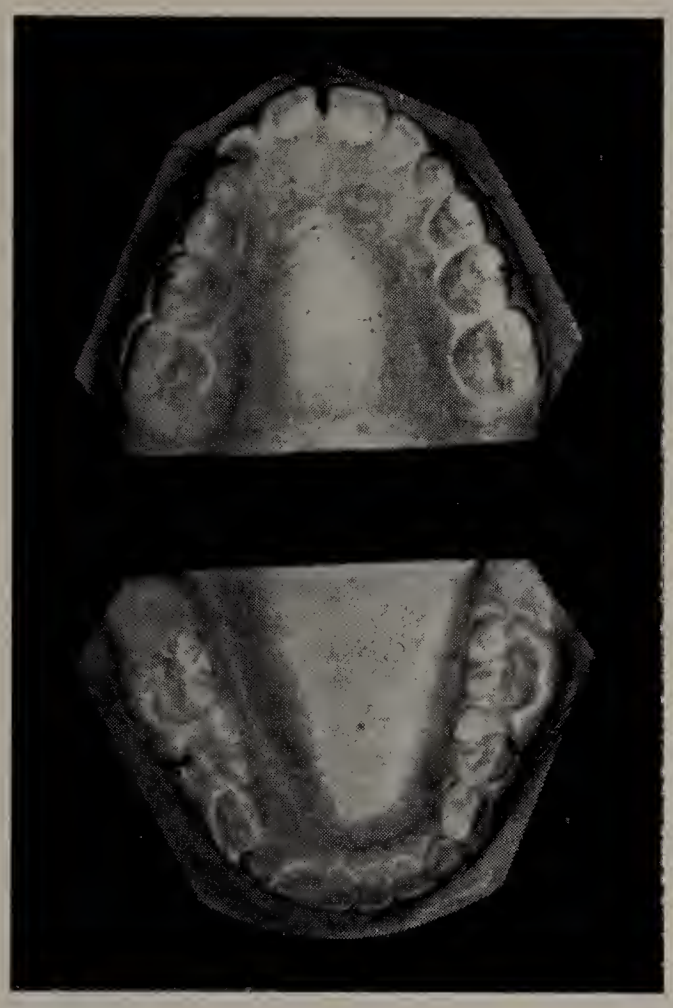


Fig. 7.—Models showing well-developed arches in reasonable occlusion despite absence of $\underline{|2}$.

Treatment in the mild cases is confined to routine dental care and whatever orthodontic treatment is necessary to produce as near normal occlusion as possible. Some beneficial results have been achieved by fitting orthodontic appliances to help to re-educate the defective muscles of the lips and tongue, but the improvement is only limited.

In the severe cases, the lack of muscle self-cleansing produces such dental chaos that orthodontic treatment is contra-indicated, and prosthetic treatment is, of necessity, the only solution.



Speech.—Pre-surgical speech therapy is not considered advisable owing to poor results achieved. Treatment by faradic stimulation of the affected muscles produces no real improvement.

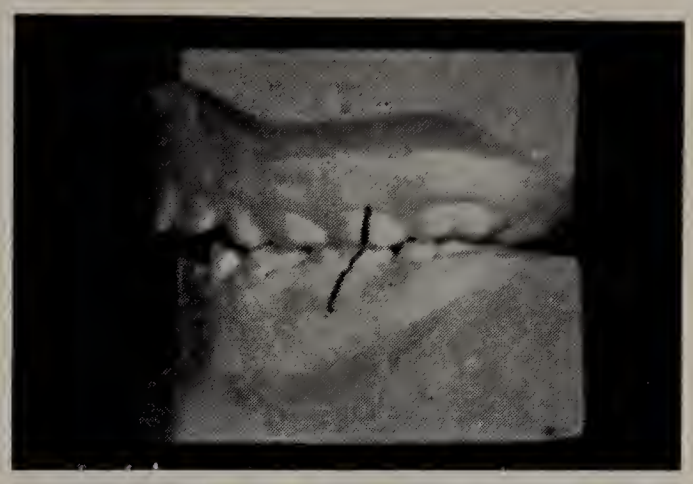


Fig. 8.—Models of *Case No.* 3. There is an anterior open bite probably due to tongue thrusting.

After pharyngoplasty, speech therapy should commence within 24 hours, if possible (Grady, 1958). This early therapy is directed to the establishment of lip-seal during swallowing,

Fig. 9.—Models show a slight Class II malocclusion. $\frac{6|6}{6|6}$ have been lost.

and education of the tongue and soft palate to swallow the saliva when it collects in the floor of the mouth.

Later, muscle movements of speech are taught, but improvement is usually slow and lack of tongue mobility seems to present the greatest problem to be overcome.

Results vary considerably, and may be greatly influenced by such factors as temperament and intelligence. It is fortunate, however, that with increasing age there is often a steady improvement, probably due to compensation of

the affected muscles, combined with assistance from the surrounding unaffected muscles.

SUMMARY

Suprabulbar paresis is described. The paresis may be partial or complete, and affects the labio-glossopharyngeal muscle complex. The lesion is in the suprabulbar region. Speech and deglutition are directly affected in accordance with which muscles are paralysed. Treatment is mainly surgical, and includes speech therapy, but orthodontic treatment may be of help.

CONCLUSION

It is interesting to consider how little malocclusion occurs in these children when the effect of soft tissue on tooth positioning is considered. A possible reason is that the teeth occupy the space between two reduced muscle forces; on the other hand it must be remembered that, apart from the orbicularis oris, the facial muscles themselves are unaffected. The problem of swallowing is difficult

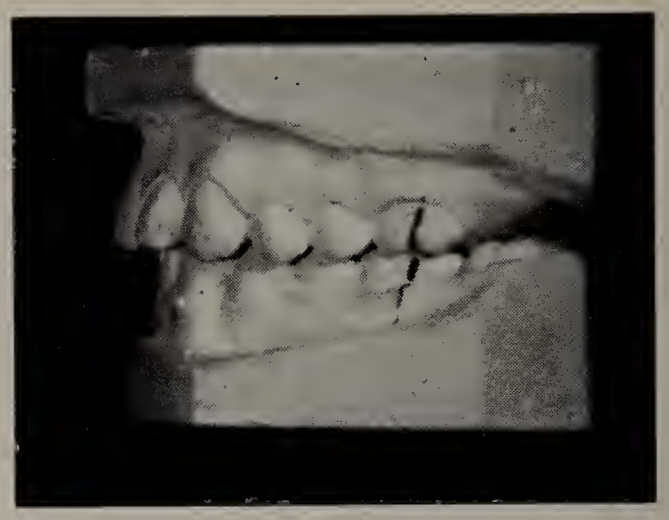


Fig. 10.—Models showing normal occlusion except for some mesial drift of the upper right buccal segment.

to assess, but the dental arches are reasonably alined despite a tongue swallow which is either completely absent or, to say the least, atypical.

It is possible that tongue volume plays an important part in tooth positioning, and although in swallowing the tongue may not rise correctly into the palate, it may occupy a position at rest which exerts lateral pressure on the upper dental arch.

Acknowledgements.—I would like to thank Mr. Worster-Drought, Mr. F. T. Moore, Mr. Wynn-Williams, Mrs. Hudson Smith, Mrs. Manning, and Miss Grady for allowing me to use freely the material from their articles. I am also very indebted to Mr. Clemetson and the photographic staff of the Queen Victoria Hospital, East Grinstead, for the preparation and presentation of the stereoscopic slides and the cine film.

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DISCUSSION

Mr. M. A. Kettle said that he was most impressed by the introduction of the stereoscopic pictures. The stereoscopic film gave a most exciting opportunity of observing the growth and development of the arches in the absence of muscle pressures. Where the paralysis was almost complete, it did not seem to him to be strange that the effect on the arches would not be noticeable. One felt that changes occurred as a result

of pressures. Had Mr. Glass observed any unilateral change where there was unilateral difference in the tone of the muscle? The nearest he had seen to such a case was an adult who was suffering from poliomyelitis and the paralysis was as complete, but, in her case, the tongue was lolling right forwards in front of the mouth and all her anterior teeth were projected forwards. That bore out what Mr. Glass had said about the effect of bulk of the tongue rather than the activity.

The incidence of caries was also very interesting. It had been noticed, in cases of unilateral palsy due to seventh-nerve palsy, that the incidence of caries did not increase particularly. One wondered how important a part the tongue played in caries incidence although, of course, where the sub-maxillary salivary gland had been removed, one felt the saliva had a greater mucous content, which perhaps would contribute to it.

It was found usually with unilateral seventh-nerve palsies that the effect on the arch was not really noticeable, and one case he had seen unfortunately had had a tonsillectomy the day before. He had been asked to see him because the right sides of the upper and lower arches were projecting forwards in the canine region and it was suggested that he had some hypertrophy of his tongue. It looked like it. He had realized it was a very interesting case and he had tried to arrange for the patient to return. Unfortunately, it took a year before he came back, and by that time the arches were normal and the tongue was normal. He wondered whether perhaps it was a secondary effect from the large size of the tonsils which had caused his tongue to project forwards to the affected side.

He was most impressed with the degree of co-operation that obviously existed between the photographic department at East Grinstead and the dental department. He hoped Mr. Glass would go on investigating those abnormal cases, because there was a lot to be learned from such an investigation.

The President asked whether Mr. Glass had ever taken models of his patients. Beautiful as the photographs were, detailed observation of models where teeth were present might possibly show variations that would be interesting, and could not be seen in the films.

Mr. Glass replied that he had models of all the cases shown and he hoped to publish some of them; models, however, whether acrylic or plaster, were not suitable for really good stereo projection.

Mr. W. J. Tulley saw that this was valuable work because it enabled them to look at malocclusions and normal occlusions developing under very unfavourable circumstances. He thought that Mr. Glass had a point when he said that because he saw so little major malocclusion it was a problem of shape and size of the soft tissues; he was not too sure that the functional aspect had been over-emphasized. He had seen a case of seventh-nerve unilateral facial palsy where the tongue was atrophied on one side. Someone had tried to do a hypoglossal transplant and failed, and there was considerable contraction of both upper and lower arches, and all the teeth were lost on that side. He thought tongue shape, size, and resting position were probably very important factors.

Miss L. M. Clinch said that the paper had been most fascinating. Mr. Glass had said that all the children had at least partial paralysis of the lip muscles: if that was so, the case of Class II, division 2 was particularly interesting because, the day before, the term "lip morphology of the Class II, division 2 type" was used several times. Obviously, if the lips were paralysed and yet one got a Class II, division 2 malocclusion it was not correct to talk about lip morphology of the Class II, division 2 type.

That brought in again the question of the term "incompetent lips". It seemed unfortunate to her that Mr. Glass had been forced to describe those cases as "*truly* incompetent". He said the term was nonsense to physiologists and anatomists. Was it not a pity that orthodontists should use a term which was not used by those who were teaching the subjects on which orthodontics was based?

Mr. A. F. D. Shapland congratulated Mr. Glass and wished to raise three small points. All the children shown had looked very cheerful little characters. Were they like most handicapped children, with a type of nature which put most of those who were normal to shame?

Secondly, when there was paralysis of movement, was there also lack of sensitivity of the palate? Was it found that there was a greater or lesser tendency to retch when taking an impression?

Some of the dentitions seemed extremely good. He wondered whether there were any comparisons with other members of the families as to whether the dentitions were good in other members of the family where they were good in the children?

Mr. A. G. Batten said that everyone had seen the sort of thing Mr. Glass had described, in various forms, in their cases in practice. They saw it in extreme infancy and extreme old age. He did not know if Mr. Glass would consider the question he was leading up to a sensible one, but was it a failure of development or was it a lack of some centre that controlled movement? The muscle movements they saw were from varying motor nerves; they were not controlled by the same motor nerve. What was the controlling factor over this paresis? Was it a failure of development, or was it something that was not there in the first place? If it was a failure of development, why, in extreme infancy, did one see that apparent paresis, the dribbling, the lack of control of the tongue, and lack of control of the lips? Again, in extreme old age, one found a similar thing occurring.

Mr. J. R. E. Mills said that it seemed to him that the tongue activity in the children varied quite considerably; those with a moderate degree of tongue activity could protrude the tongue to some extent—they could move it as a whole, but had very little control over the intrinsic muscles which determined its shape. Associated with this was a fullness or slight drooping or pout of the lower lip. Also associated with it, in cases where the dentition was visible in the film, was an anterior open bite. These features were also seen in the true or "endogenous" tongue thrust, which was so well known to orthodontists. Professor Ballard had suggested to him, privately, that the orthodontic tongue thrust was due to a central nervous system defect or abnormality. He wondered if this paper confirmed this suggestion. Had Mr. Glass the same feeling? One of the children had some activity on the right and none on the left; she had an open bite on the right side only. On the other hand, the girl with the Class II, division 2 type of malocclusion had a great deal more control of her tongue, and could flatten it like a blade.

Mr. Glass thanked Mr. Kettle for opening the discussion.

With regard to unilateral muscle tone, there was only one girl who showed a real unilateral paresis; that is a difference in degree of paresis of either side. Both sides were paralysed, but one was more severe than the other.

Poliomyelitis was a lower motor-neurone lesion and in the pharynx this presented tremendous difficulties.

Many patients could not swallow at all, and had to be fed by tube. He did not see children with polio, but only the suprabulbar paresis type. The thing about the suprabulbar cases which separated them from the polio cases was that they were present at birth before there were any teeth at all and before any soft tissue had started behaving or misbehaving. These children were therefore an interesting study from an orthodontic point of view.

He was inclined to think, as Mr. Kettle suggested, that the sub-maxillary salivary gland resection was more important in the production of the decalcification of the teeth than the lack of lip and tongue movement. The saliva of the children who had decalcification was very ropy and sticky.

He had mentioned the seventh-nerve palsies, of which he had some cases, but an analysis of the dental results was very difficult. You could compare them but you could not say that the result of the seventh-nerve palsy was this or that malocclusion because results differed so vastly. He would hesitate to draw conclusions from the odd 10 to 12 cases; he asked members to think about it, in view of the modern trend of thought that soft tissue was the main cause of dental arch deformity.

Hyperplasia and atrophy were hard to assess, but they affected the cases tremendously. In facial hæmiatrophy half the tongue was affected, and the teeth on the affected side were affected accordingly.

Miss Clinch had mentioned Class II, division 2. He would say that he thought the lips of the girl were powerful and the paresis affected only the finer movements of speech and whistling; they were from a higher cerebral centre than swallowing. Swallowing was one of the most primitive functions a child performed, and was one of the first things a child had to do in life. Speech came very much later. He thought the lips were powerful and strong and produced a considerable retraction of the teeth, but it did not alter the fact that the tongue was very powerful. She had a tongue thrust and, having such a powerful tongue thrust, why could she not be normal? It was all very well having powerful lips pulling in the upper teeth and no tongue thrust; that could produce Angle's Class II, division 2. But when you had the two together, it must be supposed that the tongue lost the battle.

On the problem of incompetence, he had used the word as he used it in everyday life. A sphincter was incompetent if it allowed things to pass through it when closed. The orthodontic definition of lip incompetence was misleading; he was sorry that a better word could not be found. He considered that some of these children showed genuine lip incompetence in that food and fluids were extruded from the mouth during swallowing.

In reply to Mr. Shapland, he said that the children were cheerful. They all lived in a special boarding-school, and were taught by speech therapists and special teachers.

With regard to the palate, like the cleft-palate child, you could touch the soft palate and they did not retch. If retching did occur the soft palate certainly needed a good deal more stimulation than that of a normal child.

He had been asking his professional colleagues for an answer to Mr. Batten's question, namely, what was the cause of the condition? Why did it hit the muscles in which they were interested? The orbicularis oris was supplied by the seventh nerve, the tongue by the hypoglossal or twelfth nerve, and the soft palate by a combination of the trigeminal and the pharyngeal plexus. Polio, on the other hand, hit the fifth, seventh, tenth, eleventh, and twelfth nerves. The neurologist considered that it was damage at about six to ten weeks of intra-uterine life of the nerve-forming areas, or maybe failure of the blood-supply which just hit the centre concerned. Apart from that, he could not say any more, but it was an interesting question; why should it hit all those muscles which were so unconnected? There was no doubt that it hit the higher centres. Speech was by far the most affected in these children.

In reply to Mr. Mills, he said that there was a girl who had a lateral open bite; she had the paresis stronger on one side than the other and she fitted into his ideas on soft-tissue behaviour. The powerful tongue pushed its way through on one side, and on the other side the occlusion was normal. Some had a tongue thrust and some had not; some brought their lower lip right inside their mouth in trying to say "th", but the lower teeth were not retroclined. He fitted an appliance with acrylic in front of the lower teeth to prevent the lower lip coming in, and speech was immediately improved.

The children presented tremendous problems which might, with analysis, help their orthodontic studies.

The President thanked Mr. Glass, Mr. Kettle, and those who had taken part in the discussion. They were fortunate in having an active and exceedingly keen member in a position to observe those rather unusual children, and they were also fortunate that he found it so easy to talk about them. He congratulated and thanked Mr. Glass. They were also tremendously grateful to Mr. Clements; the pictures were a revelation to many of them.

THE TREATMENT OF A CASE OF POSTNORMAL OCCLUSION

By **MURIEL E. H. DAVIS**, L.D.S., D.Orth. R.C.S.

WHILE many cases of postnormal occlusion are better left untreated until premolar teeth erupt, there are some which benefit from early treatment. The case here presented is one of these.

CASE REPORT

The patient was first seen at the age of 6 years 11 months. He was a healthy but slightly-built child. Neither of his parents showed any marked degree of malocclusion.

ON EXAMINATION.—The patient presented a well-cared for mouth, with no premature loss of deciduous molar teeth. The gingival condition was good, and there was a reasonable standard of oral hygiene. Intra-oral X-rays showed all the unerupted permanent teeth to be present. The dental arch relationship was one unit postnormal,

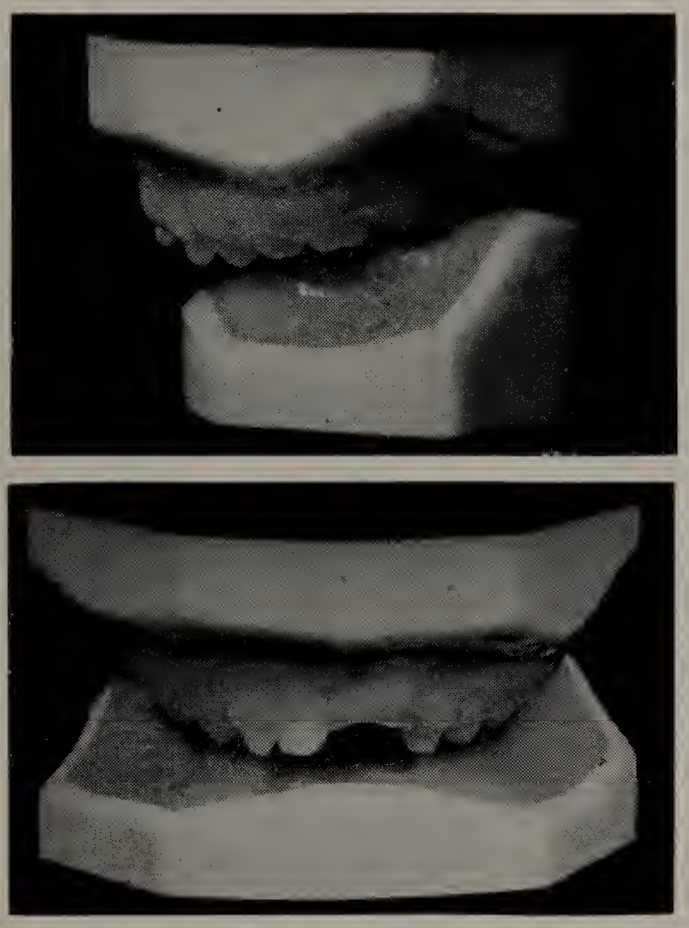

Fig. 1.—Models showing original condition (aged 6 years 11 months).

and there was a complete lingual occlusion of the lower cheek teeth. When the jaws were closed these teeth were inclined lingually and the upper teeth buccally. There was a very deep overbite, and the lower incisors were in contact with the vault of the palate (*Fig.* 1). There was an inferior postnormal apical base relationship which was reflected in the profile (*Fig.* 2). There was an overjet of 10 mm. The free-way space measured approximately 3·5 mm. The lips were in contact when at rest. The action of the muscles on swallowing was difficult to assess, but there was a marked contraction of the lower lip musculature. The speech was clear and distinct. There was no history of any sucking habits.

The child weighed 7½ lb. at birth, and although the actual birth was straightforward the first month of life

Fig. 2.—Profile at beginning of treatment (aged 7 years 6 months).

was complicated by feeding difficulties. The baby was bottle-fed, but was stated to have been "starved" during his sojourn in the nursing home where he was born. Feeding was not established satisfactorily until he was 5 weeks old. The child always had a poor appetite. During the first 5 years of life he had nasal catarrh, but the tonsils and adenoids were not removed. The only illnesses he suffered were a mild attack of measles at 4 years and rubella at 6 years.

TREATMENT.—This was delayed until the child was 7½ years of age, as the first permanent molar teeth were slow in erupting. A removable appliance with a flat bite plane was inserted in the upper jaw to prevent the molar teeth coming into occlusion. This was worn during the daytime for 12 months, during which there was some improvement in the bucco-lingual occlusion, and this seemed to be due to an expansion of the lower arch. At night an activator was worn in an attempt to correct the anteroposterior relationship of the dental arches. The activator was worn for 2½ years, during which time it was remade twice, each time in a more protrusive bite. The postnormal arch relationship was corrected at 10 years. but a deep overbite still remained (*Figs.* 3 and 4). It had been intended to continue the treatment with the

Given at the Country Meeting held at Bournemouth on May 6, 1961.

activator until the deciduous molar teeth had been shed and the premolar teeth had erupted, but owing to the boy having difficulties at school he became unco-operative, so that treatment had to be discontinued. The case was kept under observation for a further 4 years; *Fig.* 5 shows models of the case at 14 years. Lateral head plates were taken at the beginning and end of appliance treatment and at the end of the period of observation.

Fig. 4.—Profile at 10 years of age.

Tracings were made from the films taken at $7\frac{1}{2}$ years, 10 years, and 14 years. Those in occlusion at $7\frac{1}{2}$ years and 10 years were superimposed (*Fig.* 6) and at $7\frac{1}{2}$ years and 14 years (*Fig.* 7). In mandibular rest position the tracings taken from film at $7\frac{1}{2}$ years and 14 years were superimposed (*Fig.* 8).

FINDINGS.—

Measurement	$7\frac{1}{2}$ *yr.*	10 *yr.*	14 *yr.*
$\underline{\underline{\vert 1}}$ to Frankfort plane	105°	102°	109°
$\overline{\vert 1}$ to mandibular plane	89°	94°	92°
Mandibular–Frankfort-plane angle	21°	24°	24°
SNA angle	81°	81°	82°
SNB angle	71°	77°	78°
Y axis to SN plane	67°	68°	68°
Angle of convexity	16°	9°	9°
Free-way space	3·5 mm.	3·5 mm.	3·5 mm.

After $2\frac{1}{2}$ years' treatment with removable appliances a normal anteroposterior and transverse arch relationship was obtained. A reduction of 7·5 mm. occurred in the overjet, but there was still a deep overbite. When the deciduous molars were shed the premolar teeth erupted, slightly spaced and rotated, so that a normal occlusion of these teeth did not occur. A slight increase in the overjet of 1·5 mm. occurred between 10 and 14 years. From the tracings it was discovered that the upper incisor

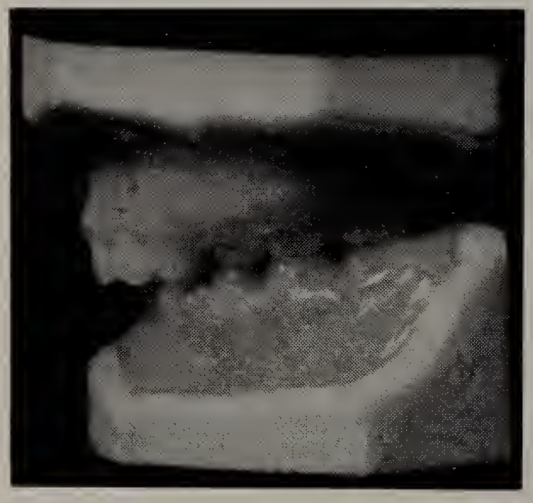

Fig. 3.—Models at end of treatment with appliances (aged 10 years).

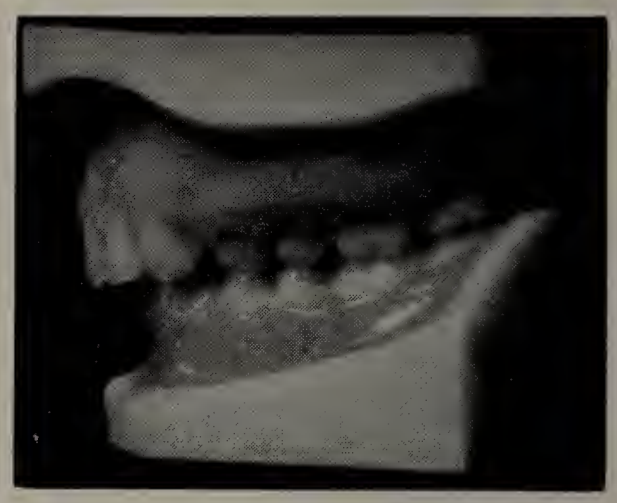

Fig. 5.—Models at 14 years of age, four years after the end of treatment.

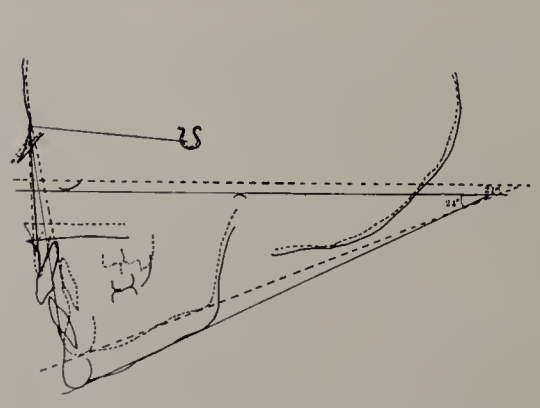

Fig. 6.—Superimposed X-ray tracings of occlusion before and after treatment (aged 7 years 6 months and 10 years), showing an increase of 6° in the SNB angle (from 71 to 77°).

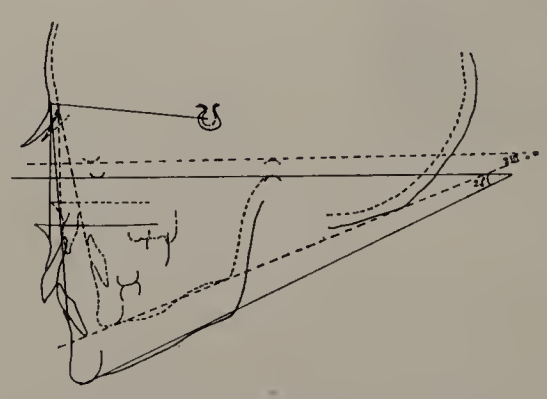

Fig. 7.—Superimposed X-ray tracings of occlusion before treatment and four years after treatment (aged 7 years 6 months and 14 years), showing an increase of 7° in the SNB angle (from 71 to 78°).

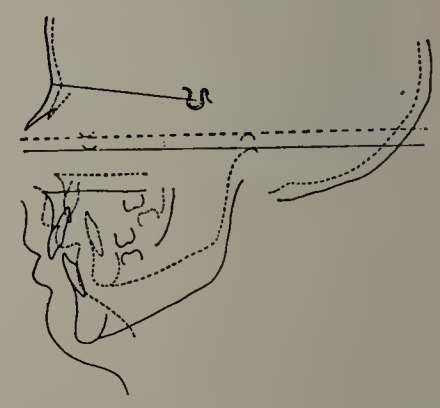

Fig. 8.—Superimposed X-ray tracings, showing the mandibular rest position at 7 years 6 months and 14 years of age.

teeth had become proclined by 7° and the lowers retroclined by 2°. A very small increase of 1° had occurred in the angle made by the Y axis to the SN plane. The mandibular–Frankfort-plane angle increased by 3°, but was still at a fairly low value. A marked straightening out of the angle of convexity occurred during treatment as the angle decreased by 7°; this did not change during the observation period.

During the period from $7\frac{1}{2}$ to 14 years the SNA angle increased by only 1°. The SNB angle, however, increased from 71 to 78°, an increase of 7°. In an unselected group of 20 of my treated cases who had an inferior postnormal arch relationship on postnormal apical bases the greatest increase noted was 4°, and that occurred in only 1 case, all the others showing no change or increases of 1–3°.

SUMMARY

The case just described seems to demonstrate the effect of intercepting a severe malocclusion at an early stage and how a large increase in the value for the SNB angle from 71 to 78° was obtained.

DISCUSSION

Mr. J. W. Softley thanked Mrs. Davis for bringing the case forward in a very well-documented manner, and for giving him the privilege of opening the discussion.

The case had several interesting features, of which the first was the complete lingual occlusion of the lower arch. Mrs. Davis had said that it did not look very promising, but she also said that the uppers were inclined buccally and the lowers lingually, and it would appear that the transverse relationship of the apical bases was not altogether unfavourable. Possibly an anterior–posterior X-ray as well as a lateral view might have led her to think rather differently on that point.

One would not be surprised to find, with that arrangement of the teeth, a restriction of function, a vertical overdevelopment of the alveolus carrying the teeth, which might affect the estimation of the free-way space, a deep overbite, and an overclosure of the mandible.

One might also expect to see a condition which the Scandinavians described as a "forced distal occlusion", in which they did not mean that the condyle was just placed distally in the glenoid fossa, but believed that the direction of condylar growth was forced to be more backwards than the downwards and forwards growth normal for that individual.

That, of course, was pure speculation, but he could persuade himself that a potentially normal, or almost normal, arrangement of the teeth could, by a failure of bucco-lingual integration, turn into the type of case Mrs. Davis had described.

Also, positive pressure was being applied which might affect the form, the opposite thing to the lack of function dealt with in the last paper.

To his mind, there was no doubt that early intervention was indicated, at least to the point of correcting the bucco-lingual occlusion. In that connexion he would have thought that the bite-plate played a far more important part than the Andresen appliance, although that appliance had some popularity some years ago, as they had heard yesterday. They had also heard that even the most unlikely cases might be self-correcting, but the most hardened advocate of late intervention would not quibble at early treatment when such a definite objective was in view. In fact, provided co-operation was there, he would have been inclined to treat it in the deciduous dentition, and not wait for the first permanent molars. Perhaps Mrs. Davis could give her views on that.

After the bucco-lingual occlusion was treated, and corrected perhaps there would have been a case for postponing further treatment until later.

The increase of 7° in the SNB was interesting and important. Was there a steady increase over the time the appliance was worn or was there a comparatively rapid improvement at first, associated with the bite-plate, followed by a slower increase later on? It did not do to be too rigid in believing in the immutability of the skeletal pattern. Mr. Tulley had shown a case the day before, Class III; there was Mrs. Davis's case; and he had seen a few which did not fit the usual explanations.

He did not want to say any more than that, but these cases did create a little doubt and they should keep open minds on the subject.

Mr. C. D. Parker congratulated Mrs. Davis. He wondered whether some of the improvement seen on the photographs was due to a forward posturing of the mandible after treatment, and, in that connexion, had Mrs. Davis figures of SNA/SNB at rest before and after treatment?

Mr. K. E. Pringle said that there had been a case at Guy's of micrognathia that was almost exactly the same as Mrs. Davis's. Mr. Breakspear had started to treat it with a monobloc. The boy seemed to grow round the monobloc. It seemed to him that there was a growth potential in such early cases; they were not really at their maximum development when they were seen.

As to the lingual occlusion of the lower teeth, a certain amount of this was due to the bite; once the lower cheek teeth had slipped lingually to the upper cheek teeth, they were forced even more lingually by the bite. In the same way the upper cheek teeth were forced buccally. Cases of the kind described occurred, but were rare.

Mr. W. J. Tulley said that Mr. Rix had described a case which was very similar.

Professor D. P. Walther said that the rather gross postnormal dental base cases were very interesting. He was particularly interested, at Great Ormond Street, in such cases. On going through the charts of the older cleft-palate children, who had a cleft of the palate only, he found that quite a number of them were only very slightly postnormal; yet when he went through the notes and also looked at the photographs, they were put down as Pierre-Robin syndrome with considerable micrognathia. Those were the sort of cases they made their name on. He wondered whether the Andresen was acting like the little black box but in the mouth instead of the pocket?

Miss L. M. Clinch thanked Mrs. Davis for her paper. She thought the Andresen was working, not like a little black box, but in the mouth.

She had treated one of those cases who unfortunately she had seen for the first time as the premolars were erupting, and had been quite unable to cure it. She had been almost unable to improve it, despite great

co-operation on the part of the patient. It was not the boy's fault that progress was bad, and despite all kinds of appliances she had not been able to get more than a very minor improvement. She therefore thought that Mrs. Davis was right in tackling this child early.

She congratulated Mrs. Davis on having her models cut with the occlusal plane at its correct angle to the Frankfort plane instead of parallel to it as is usually done. It gave a very much clearer picture of what the malocclusion really was. Sometimes one saw a pair of models which did not appear to relate at all to the patient because the angle of the incisors looked so different on the models.

Mr. E. K. Breakspear congratulated Mrs. Davis on a most interesting paper. He had one question to ask. The very first line on the table was the angle of the upper incisors with the Frankfort plane. If he remembered correctly, the final angle was 109°, which was higher than it was originally. Could Mrs. Davis explain that?

Mr. D. F. Glass said that some of those cases did respond to treatment. However, if there was a mandibular agenesis due to trauma or infection in early life, he did not think much could be done about it. If it was developmental, probably something might be done.

With Pierre-Robin syndrome, Baume, Haupl, and Stellmach, of Dusseldorf, fitted external traction of about 100 g. to the mandible to pull it forward. The traction was attached to a beam above the bed. Good results are claimed by this method, and a monobloc might do the same over a long period.

Professor D. P. Walther stressed that the cases he had looked into had had no appliances whatever.

Mr. S. Haynes thanked Mrs. Davis for her paper, which pointed out that they, i.e., orthodontists as a whole, were perhaps too dogmatic when they said that the skeletal pattern did not change or the soft-tissue pattern did not change. It was interesting to look at the figures and notice that the *Y* axis remained the same, whereas there was a marked change in the SNB angle. He had had a similar case, of a child who was a vicious thumb-sucker. He gave no treatment, but on seeing him the child stopped the habit, and there was a similar result which suggested that perhaps there was a change in pattern even without treatment being given. Would Mrs. Davis comment on that?

Mr. G. C. Dickson thanked Mrs. Davis for a very interesting paper. The case was one which did not fit into any routine type of Class II case which they had to treat most of the time. Obviously such cases were relatively rare. None of them could have an opportunity of seeing very many of them in their orthodontic experience. He wanted to take the opportunity of saying that that was why all such cases ought to be described and published, as Mrs. Davis had done. It was a great help, particularly if they had not been treated, and only in such a way could they bring enough cases together to cut out the speculation as to whether it was growth or treatment which had produced the changes.

The President said that the interest produced by the reporting of the case showed how much case reports were appreciated. He supported Mr. Dickson in saying that they would like to have a great many more. They tended to get stuck in their own little backwater, and all kinds of interesting things went on outside; it was only by bringing cases forward and describing them as expertly and clearly as Mrs. Davis had done that they could benefit from their association in the Society.

The President then said that he could see Mr. Chapman in the hall and Mr. Chapman had not been to a meeting since he had been elected an Honorary Member. No one would wish the occasion to pass without his saying how delighted they were to see him. They hoped they would see him again on many, many occasions (*Applause*).

Mr. Chapman thanked members for the honour they had done him in recently electing him an Honorary Member.

Mrs. Davis thanked Mr. Softley for opening the discussion. She had thought about the case a lot more when she had a case similar to that described by Miss Clinch. The unfortunate boy was 15 when he came to see her. He had had treatment in East Africa, and the idea had been to put in a covered molar appliance in the lower jaw with expansion, which he had worn for about two years. Consequently, the lower teeth were almost at gum level and the upper teeth outside the arch. She could not do anything with him. She had thought how much nicer it would have been had she seen him when he was young. That was how her interest had been aroused in such cases. She had not been able to treat successfully any cases of that type of malocclusion in the permanent dentition. If anyone could suggest how she could do it, she would be grateful. She had had complete failure. If she did see anything like that in the deciduous dentition, she would go ahead and treat.

On the point about the bite-plate, she had felt that the thing to do was to try to stop the teeth getting into occlusion, give the tongue a chance to work and, if the lower teeth tilted lingually, give the tongue a chance to push buccally. It was a bit difficult to get lateral head plates, and they were only taken at the beginning and end of treatment so she could not answer about the SNB angle except that it did change. It was interesting in view of what Professor Ballard had said the day before about spacing in the upper jaw when premolars came into occlusion, and that might be an explanation of that particular case.

She could not answer Mr. Parker's question then, but would look into it and let him know.

She was most interested to hear of Mr. Pringle's case of the mandible growing round the appliance. It almost looked as though that was what happened in her case. She had thought the little black box would crop up somewhere, and Professor Walther had not disappointed her. She had not seen many of the Pierre-Robin syndrome cases. She had one patient who was reputed to be. She had seen the child at 6 months and supposed that she was going to have headaches for $14\frac{1}{2}$ years or so with that patient!

Mr. Breakspear had mentioned that the upper incisors were at 109° at the end of treatment. They were. She thought she had probably over-retracted the incisors during treatment. That must be the explanation.

She thanked Mr. Glass for his remarks and said that it was gratifying to hear his view about response to treatment expressed. She had been disappointed that she had not got any change in the *Y* axis; she thought she would probably have got a marked one because she had a decrease in the angle of convexity. She had checked and re-checked and could not find anything wrong. She could not get the *Y* axis to do anything but remain relatively unchanged. The only thing would be if the mother had twins and for her to treat one and not the other, but even if one did get twins like that, one could not leave one untreated and treat the other, much as one would like to.

THE AETIOLOGY OF MALOCCLUSION

A Preliminary Report on a Comparative Survey of Bristol Undergraduates and Schoolchildren

By J. C. STEPHENSON, B.D.S., F.D.S., D.Orth. R.C.S.
The University of Bristol, Dental Hospital and School

In his Northcroft Memorial Lecture of November, 1960, Mr. Rix stated: "Are we right in assuming that incompetent lips will always remain incompetent? It would be valuable to discover by scientific methods whether the effort to seal such lips ever at least becomes less (disregarding any reduction of effort which would follow treatment to improve the anteroposterior incisor relationship). A reduction of effort would presuppose some changes in lip morphology."

Last year a cross-sectional investigation of this problem was undertaken in order to compare groups of children and young adults in numbers sufficient to demonstrate significant differences. A proportion of the undergraduate population was examined during attendance for the annual compulsory miniature chest X-ray in October, 1960. Children were examined during visits to schools whilst accompanying school dental officers, who were carrying out routine inspections. Each examination took some 3–4 min., records being taken for 218 students and 348 schoolchildren.

Edge-perforated cards were attached to a diagnostic key, information being recorded by ticking against the appropriate holes on the cards for punching later.

The intention was to compare certain features of children and young adults, and not to relate certain factors within each group, as this has been studied more fully in recent publications by Gardiner (1955), Leech (1958), and Walther (1960). The students came from all faculties; only those within the age range 18–26 were examined. The children were in three comprehensive (with grammar and secondary modern streams) and three junior mixed schools; only those within the age range 9–13 were examined. Observations on 37 children at one junior mixed school seen early in the survey were eliminated, as the method of examination was not thought to have become consistent at that stage.

The Frankfort–mandibular-plane angle was measured clinically by the method described by Tweed (1946) and the skeletal pattern assessed according to Ballard (1948). The examinations were carried out using tongue spatulas to part the lips in order to inspect the occlusion, so that the classification of occlusion has been assessed

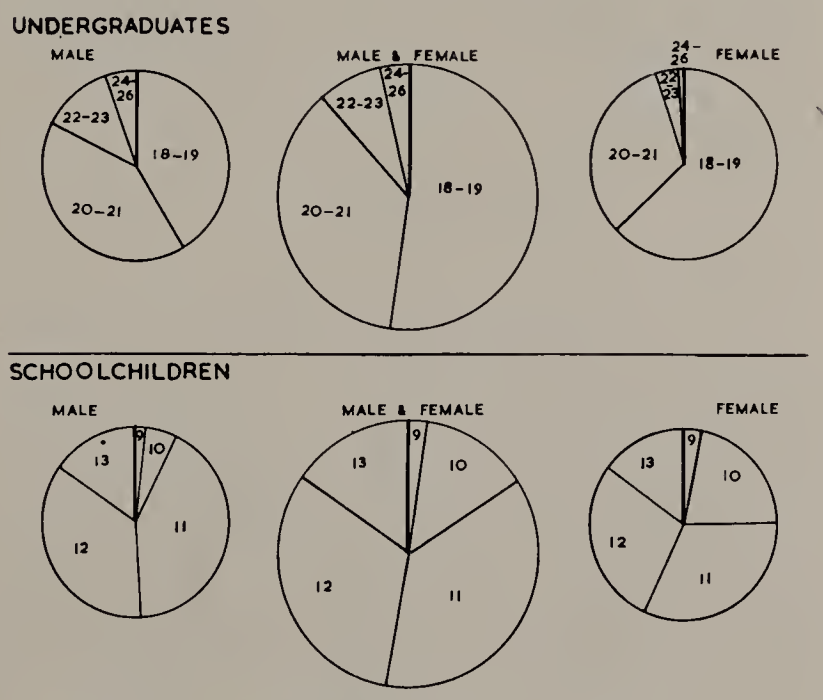

Fig. 1.—Age distribution of the two groups.

on the labial segment relationship alone. There being only one observer, a grouping for "uncertains" was not included as it was felt that this would only increase the difficulty of classifying them. For those Class II cases having retroclined upper incisors and an increased overbite, but which also had an increased overjet or some other feature more typical of Class II, division 1 than Class II, division 2, the term "Class II, division 2 type of Class II, division 1" was used.

Fig. 1 shows the age distribution of the two groups; males and females separately and then combined. These proportions have been plotted, not as percentages, but as degrees or 360ths. There were 45 male and 69 female

Given at the Country Meeting held at Bournemouth on May 6, 1961.

18 to 19-year-olds, 44 male and 35 female 20 to 21-year-olds, 13 male and 5 female 22 to 23-year-olds, and 6 male and 1 female 24 to 26-year-olds. Proportions of the various faculties were as follows: For 108 male undergraduates—18 medicine, 39 science and

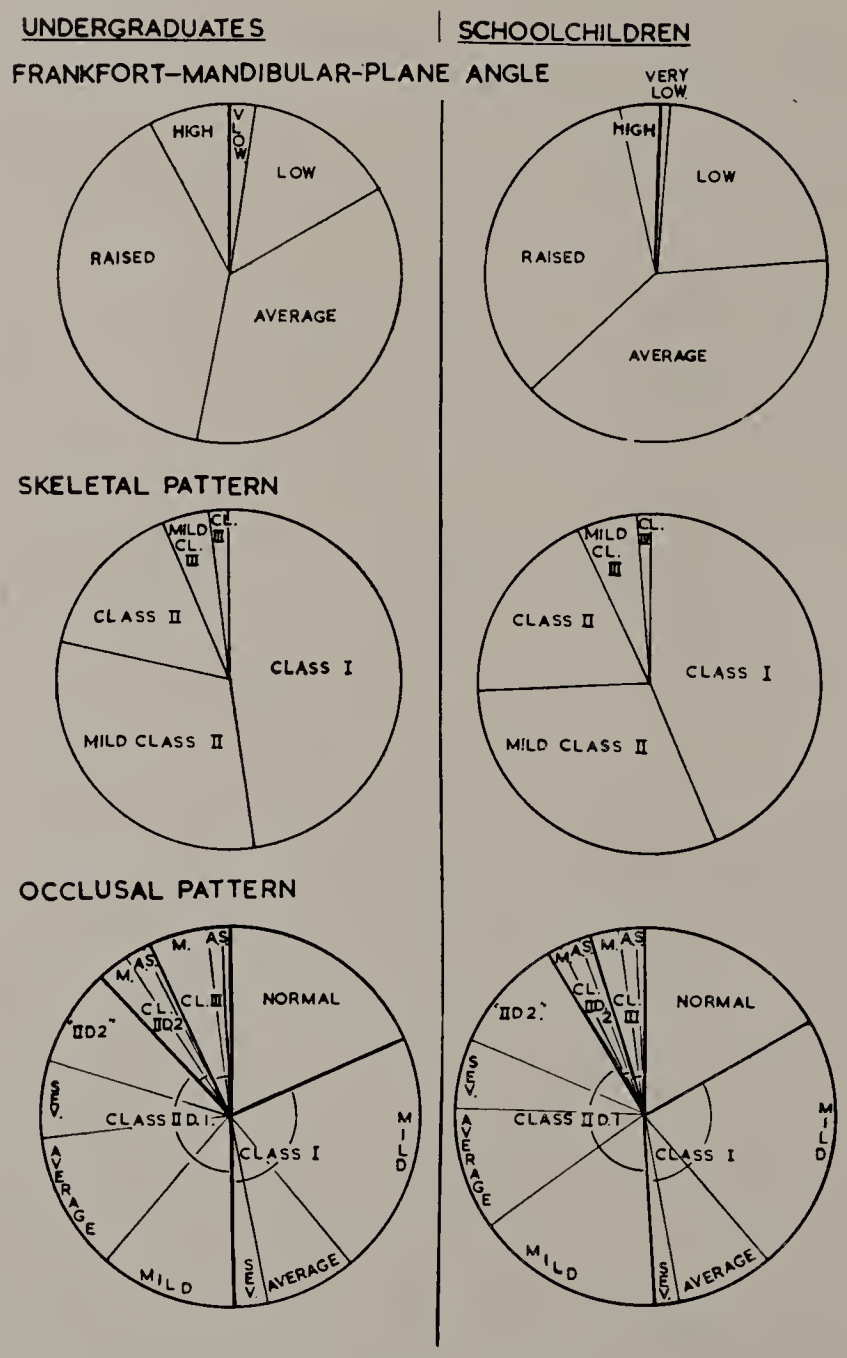

Fig. 2.—Comparison of Frankfort–mandibular-plane angles, skeletal patterns, and occlusal patterns.

engineering, 35 arts, 10 law, and 6 theology. For 110 female undergraduates—14 medicine, 38 science, 52 arts, and 6 law. In the school group were 2 male and 5 female 9-year-olds, 8 male and 34 female 10-year-olds, 64 male and 51 female 11-year-olds, 54 male and 44 female 12-year-olds, and finally 24 male and 25 female 13-year-olds.

The number of undergraduates giving a history of definite orthodontic treatment with appliances, or involving the extraction of sound teeth to make room for "straightening the rest", etc., and appreciating the meaning of the word "orthodontics", was surprisingly high—71 cases out of 218. However, one can assume that this was a group of young people whose parents had tried to give them the best possible start in life, their treatments being carried out not just in the Bristol area but also throughout the country. Only one student was undergoing active treatment, whilst 20 children gave a history of past orthodontics and 21 of actually undergoing it at the time. As a check on the consistency of this information they were also asked if their parents were denture wearers and bearing in mind the age differences of the two groups, and also the differing social and intellectual backgrounds, the undergraduates' 121 fathers/121 mothers (55 per cent and 55 per cent) to the children's 131/152 (42 per cent–49 per cent) can be considered comparable.

Fig. 2 compares Frankfort–mandibular-plane angles, skeletal patterns, and occlusal patterns.

Table I.—Frankfort–Mandibular-plane Angle

Undergraduates	*Schoolchildren*
5 Very low	2 Very low
31 Low	70 Low
79 Average	121 Average
85 Raised	106 Raised
18 High	12 High
218	311

It will be noticed that the proportions of average and raised Frankfort–mandibular-plane angles are much the same in both groups, with the low angles emphasized in the children and the raised ones in the students. This may well be an observer error as in the children there may have been a tendency to read the angle low because of the relatively greater amount of soft tissue covering the angle of the mandible, whilst with the adults a reverse process may have operated.

Table II.—Skeletal Pattern

Undergraduates	*Schoolchildren*
104 Class I	136 Class I
67 Mild Class II	95 Mild Class II
33 Class II	58 Class II
10 Mild Class III	18 Mild Class III
4 Class III	4 Class III
218	311

The skeletal pattern ratios of the two groups are very similar with, if anything, a suggestion that other observers might have assigned a number of the "mild Class II" cases to Class I.

Table III.—Occlusal Pattern

Undergraduates		*Schoolchildren*	
40 Normal occlusion		51 Normal occlusion	
67 Class I	47 mild	101 Class I	70 mild
	15 average		27 average
	5 severe		4 severe
85 Class II, div. 1.	26 mild	133 Class II, div. 1.	52 mild
	27 average		36 average
	12 severe		16 severe
	20 II div.2		29 II div.2
11 Class II, div. 2	6 mild	11 Class II, div. 2	3 mild
	4 average		5 average
	1 severe		3 severe
15 Class III	11 mild	15 Class III	8 mild
	3 average		5 average
	1 severe		2 severe
218		311	

In each group the sum total of Class I and mild Class II and III cases constitutes virtually 80 per cent of the total.

The occlusal pattern groupings, as assessed on labial segments only, correspond more closely, and it might not be possible to show any significant difference between them. The groups can be seen to have been subdivided according to severity, and it is of interest to note that the mild Class I cases form as large a group as those with normal occlusions. In addition the "Class II, division 2" type of Class II, division 1 groups is quite large; other observers might well have distributed them between the true Class II, division 2 grouping and Class II "Indefinites".

Fig. 3 compares lip morphology and assessments of the state of the occlusion.

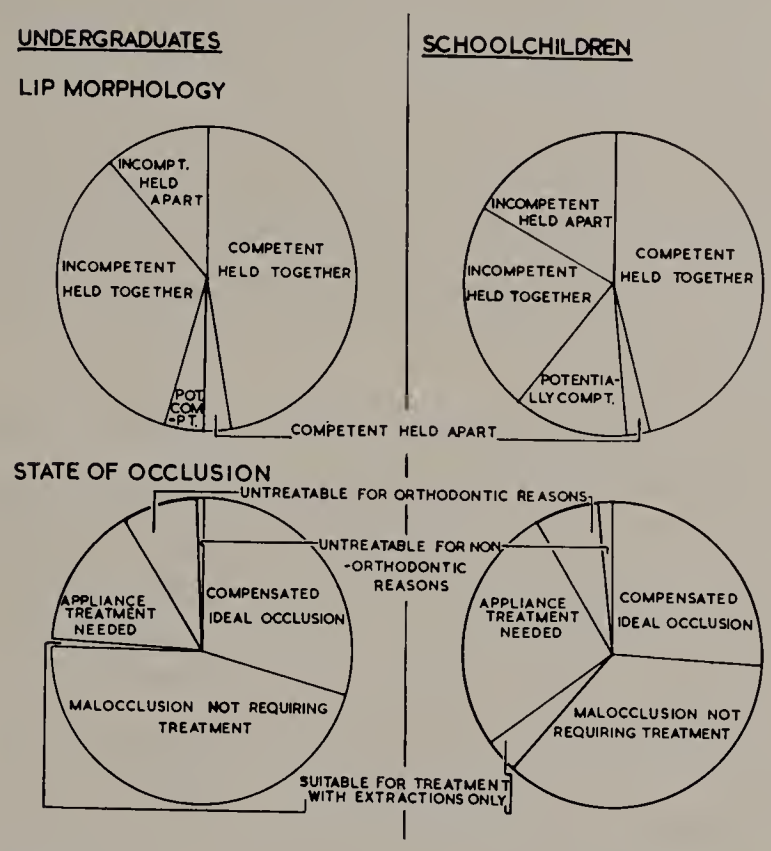

Fig. 3.—Comparison of lip morphology and assessments of the state of occlusion.

Table IV.—Lip Morphology

	Undergraduates	*Schoolchildren*
Competent held together	103	143
Competent but held apart	6	8
Potentially competent but dentally obstructed	9	38
Incompetent held together	75	69
Incompetent held apart	25	53
	218	311

Table V.—Swallowing Behaviour

	Undergraduates	*Schoolchildren*
Abnormal swallow	76 (35 per cent)	123 (40 per cent)
With "ooze"	35	75
With active tongue-thrust	28	35
With vigorous tongue-thrust	13	13
Related Factors		
History of thumb-sucking	34 (16 per cent)	29 (9 per cent)
Presence of obvious speech defect	23 (11 per cent)	58 (19 per cent)

Table VI.—State of Occlusion

	Undergraduates	*Schoolchildren*
Compensated ideal occlusion	64	81
Malocclusion but no treatment required	100	111
Treatment with extractions only	1	11
Appliance treatment needed	33	82
Untreatable for orthodontic reasons	18	22
Untreatable for non-orthodontic reasons	2	4

In setting up the investigation it was necessary to have a hypothesis on which to determine the actual numbers to be examined. On the grounds of clinical experience it was assumed that one might expect to find in a group of schoolchildren 40 per cent with competent lips, 40 per cent with incompetent lips, and 20 per cent about whom one would be

uncertain; whilst in a group of undergraduates 50 per cent might have competent lips, 30 per cent incompetent, and 20 per cent again uncertain. In other words, it was anticipated that, allowing for "uncertains", growth might have resulted in a 10 per cent rise in the number with competent lips. To show this statistically—assuming a probability level of 5 per cent, i.e., a 1 in 20 possibility of difference being due to chance, and a standard deviation of the difference of 5 per cent—the indicated group sizes could be of the order of 200 individuals.

This assumption was not, in fact, borne out by the actual findings, which suggest that the two groups exhibit virtually identical proportions of competent lip morphologies with the lips together and with the lips habitually apart. The term "competent" is used to describe lips that are able to produce an anterior oral seal with the mandible in the endogenous postural position without any active contraction of the anterior oral musculature.

The group classified as potentially competent, i.e., that would be competent were their lips not habitually apart due to dental obstruction, is much larger in the children and has not, as had been expected, contributed to a higher proportion of competent lip morphologies in the undergraduates (however, one must bear in mind the high proportion of students with a history of past orthodontic treatment). Rather, there appears to be a higher proportion of undergraduates who were assessed as still being incompetent, but whose lips are held habitually together, and a lower proportion who are incompetent with lips held apart. Thus, for the numbers examined so far, it has not been possible to show any statistically significant increase in the proportion with competent lip morphologies, whilst the number with "incompetent lips held together" appears to increase at the expense of the "incompetent apart" and "potentially competent" groups.

Abnormal swallows were evident in 35 per cent of the students and 40 per cent of the children; an abnormal swallow being one in which there is a thrust of the tongue forwards between the upper and lower incisors, with the buccal teeth in or out of occlusion, accompanied by a contraction of the circumoral musculature. The difference of 5 per cent is largely within the limits of observational error for the numbers examined so far, and no conclusions should be drawn from it as yet. Most of the abnormal swallows involve, in fact, only a very mild tongue thrust or "ooze". These figures compare with the 29 per cent Rix (1946) found and the 43 per cent of Leech's survey (1958). Figures for the incidence of thumb-sucking suggest a reluctance on the part of the schoolchildren to admitting that they might have done so beyond the age of $7\frac{1}{2}$ years; 16 per cent of the students and 9 per cent of the schoolchildren did in fact give such a history. Obvious speech defects were thought to be present in 23 of the undergraduates (11 per cent) and in 58 of the schoolchildren (19 per cent).

Observations on the state of the occlusion show that whilst the compensated ideal occlusions, i.e., cases which, whilst not necessarily on a normal skeletal base, have, in fact, produced ideal occlusion of the labial segments, form over a quarter of each group; also the "malocclusion requiring no treatment" group is much larger in the students. However, as already mentioned, 71 students had had orthodontic treatment of one form or another; some of these cases could have benefited from such treatment. The proportion of children requiring treatment with appliances or extractions only is 30 per cent, falling to half this figure in the adult group. The proportions considered untreatable are similar, with 18 students and 25 children so classified for orthodontic reasons, i.e., gross skeletal or soft-tissue anomalies, etc., whilst 2 students and 5 children were found to be untreatable for non-orthodontic reasons, i.e., gross caries, dentures, etc.

In criticism of these findings, the university group is, of course, a highly selected one from a different social and geographical background to most of the comprehensive and junior mixed schoolchildren. However, they form a group of young adults with a good standard of

dental health and it is considered that an adult group taken from a similar social background to that of the children might also be equally questionable, due to the number of so-called "dental cripples" amongst them. As mentioned previously, 37 schoolchildren were excluded from the findings as a result of uncertainty as to the consistency of the method of examination. All undergraduates and schoolchildren of foreign extraction were excluded from the survey. A random sample was anticipated by examining the next individual to reach the observer after completing the records on the previous one. One group of 16 girls and 14 boys seen at a junior mixed school early in the survey was reassessed after 4 months, and it was found that whilst exact agreement in observations was seen for only 7 children out of the 30, the mistakes were largely of degree only. It may be mentioned here that these younger children were the most diffcult individuals to classify of any seen in this survey; the edge-perforated cards used had over a hundred holes apiece. For example, the Frankfort–mandibular angle showed 3 cases going up from average to raised, 3 cases of raised dropping to average, 1 low to average, 1 low to raised, and 1 raised to high, whilst for swallows 1 normal became abnormal and 2 abnormals became normal. The margin of error has not been expressed statistically, as assessments of factors determined vary so much from "objective" to dominantly "subjective", that it could not be expressed as a single amount.

CONCLUSION

A survey of 218 Bristol undergraduates and 311 schoolchildren shows that there appears to be a broad similarity between the two groups, with the suggestion that whilst the proportion of "competent lip" morphologies remains the same, there is a rise in the proportion of "incompetents with the lips habitually held together" at the expense of the groups having "potentially competent" lips and "incompetent lips held apart".

Acknowledgements.—I wish to thank Mr. W. A. Nicol, Professor Ballard, and Dr. M. V. Stack for their encouragement and assistance in preparing this paper; Professor Bradford and the Bristol University authorities, and Mr. McCaig, of the Bristol School Dental Service, for arranging for me to see and examine the undergraduates and schoolchildren respectively; the dental officers, headmasters, and others who gave me every assistance in the practical details of the survey; finally, Mr. F. D. Godman, of the University of Bristol Medical Photographic Department, for the illustrations.

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DISCUSSION

Mr. W. A. Nicol, in opening the discussion, said that he doubted if he could raise much criticism of it because he had been rather too close to the work while it was being done.

There were two things which were worth underlining. The first was that the purely physical structures such as teeth and skeletal patterns were very similar in each group. One would expect them to be similar as there had been previous work in this field to suggest this. Mr. Stephenson had gone to great lengths to try to test the accuracy of his findings. His findings on the structural features confirmed his accuracy.

This added significance to the second point. He was expecting some change between the young group and the old group in muscle patterns and behaviours (he admitted as much when he was going into the statistical part of the paper), but he did not get one. The fact that he was expecting a certain result and did not get it added to the accuracy of that result. Quite a lot had been written in the *Observer* recently by Arthur Koestler about the accuracy and otherwise of experimental work. He had described how preconceived ideas could influence the results to quite an extraordinary degree.

Mr. Nicol said that he hoped that the work would go on, and that there would be more results and many more valuable pieces of work of its kind. They had to have theories on which to work, and they had to go on testing those theories all the time.

Professor C. F. Ballard congratulated Mr. Stephenson and Mr. Nicol and emphasized the importance of the study of groups. It was laborious work. It was difficult

to find people with the time; it was difficult to find the money to do it, but it was absolutely essential.

As far as Mr. Stephenson's paper was concerned, Mr. Stephenson was himself well aware of the criticisms which would be raised when cross-sectional groups were compared at different ages with different appliances, etc. What was more important, some of the students were not born and bred in Bristol. That was one of the things that would interest them in speech. It was the sort of thing that was raised in Professor Walther's paper where he was comparing groups who, quite possibly, were racially different and different in detail, but it might come out in a statistical analysis which was sufficiently detailed.

In order to avoid that, long-term longitudinal studies were required; the sort of thing Professor Walther had been doing. They needed a lot of planning and a lot of money. He did not know where they would get the money in this country, but he hoped it would be possible to find the time and the money to continue with that sort of research.

Professor D. P. Walther was longing to get into a corner with Mr. Stephenson on the figures because he was not quick enough to take them all in at one glance. They had more or less arranged to compare their figures, and he was looking forward to that very much indeed.

Mr. G. C. Dickson thanked Mr. Stephenson for a very interesting paper. He did not think he could say very much about the paper; the results were there for detailed study, and by just looking at it as they had done they could not appreciate the significance of the differences. There was one suggestion which he hoped Mr. Stephenson would not take as a criticism, but as a constructive suggestion. He did not think "pie" diagrams suitable for all the information given. "Pie" diagrams were suitable for things that added up to 100 per cent. Personally, he would find it easier to understand histograms.

Mr. S. Haynes congratulated Mr. Stephenson on his work, which he thought was very good. Had Mr. Stephenson encountered any cases of normal occlusion with incompetent lips and abnormal swallow? On the other hand, had he encountered any Class II, division 1 malocclusions with competent lips and a normal swallow?

Mr. A. E. Parrott complimented Mr. Stephenson on his paper, particularly on the speed with which he was able to collate all that information in a matter of three months.

He asked for clarification on one point—the classification of the students who were untreatable. Would he have regarded them as untreatable had he seen them as small children, or were they untreatable by any standards at any age!

Mr. Stephenson thanked Mr. Nicol for opening the discussion, and both him and Professor Ballard for their remarks. He had ideas for expanding the scope of the paper, but it had been his intention, at this stage, to attempt only a partial answer to the question that Mr. Rix had raised. For that reason, he had not produced further information, because for group sizes of the order of 200 one would find that certain groupings and subdivisions (e.g., of Class III malocclusions) would be in single figures, and it would be "sticking one's neck out" to quote these as percentages.

He thanked Professor Walther for his remarks and said he would much appreciate an opportunity to get together with him and compare findings.

He fully agreed with Mr. Dickson's remarks about diagrams, but as his sample sizes were relatively low, he had deliberately avoided showing the proportions as percentages. Thinking back, he would have liked to have had a minimum of 500 in each group, and ideally 800 or so. He had asked Dr. Stack how many he would have to have had in each group with "competent lip morphologies", to show a statistically significant difference between them, bearing in mind their marked similarity at this stage. Dr. Stack had said that he would have to have numbers in each group of at least 800. He considered that in a sample of this size, for this purpose, the observer error in assessing lip morphologies might tend to nullify the small difference found.

In reply to Mr. Haynes, he thought that there would be a number of individuals within the groupings mentioned. It would be perfectly possible to extract this information from the punched cards.

Mr. Parrott had asked about the criteria for determining which individuals required orthodontic treatment. Both the undergraduates and the schoolchildren, who were classified as requiring treatment, were so placed by the actual state of their occlusions at the time of the examination, irrespective of their age, past treatment, etc. For example Mr. Stephenson happened to be himself treating the one undergraduate found to be undergoing active treatment; this involved appliance therapy to aline a labially placed upper canine, i.e., a fairly typical adult orthodontic case being treated with the minimum amount of tooth movement necessary for a satisfactory result.

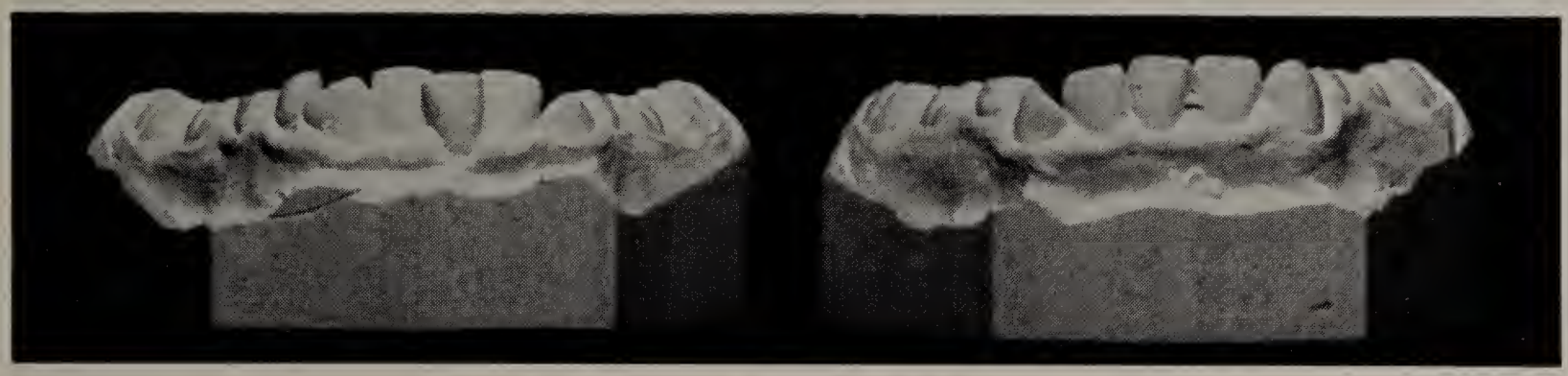
The President thanked Mr. Stephenson, Mr. Nicol, and those who had taken part in the discussion. Mr. Stephenson was a young member of the Society, and as long as his employers would grant him the time to go on with the investigation, they would all encourage him to do so. He might reach the figures he aimed at, given time.

EXTRACTION OF LOWER INCISORS

By **DOUGLAS MUNNS, L.D.S. R.C.S.**

It is generally recognized that although there may be much overcrowding in the lower anterior region, lower incisor teeth should not be extracted as part of orthodontic treatment or there will almost certainly be a collapse of the lower arch (possibly with worse imbrication of teeth than before) and also collapse and consequent overcrowding in the anterior region of the upper arch. Believing that there were certain exceptions to this rule, we have, over the past few years, been extracting lower incisors in certain selected cases, these falling into two main categories:—

Group 1: Young children who present with imbrication of incisors which could not be immediately corrected by removal of deciduous canine(s) (*Fig.* 1). If this irregularity is left until premolars erupt and then removal of a unit in this region followed by retraction of canines is practised, it will probably be four or five years after the patient's first visit before good alinement of incisors is obtained. During this period, the periodontal condition will have deteriorated considerably and may well lead to the loss of lower incisors in early adult life that is so common to-day. (*Table I.*)



A B

Fig. 1.—Patient aged 9 yr. A, Before extraction of $\overline{|1}$; B, Four months later.

Table I.—Group 1

Case No.	Age	Angle's Classification	Teeth Extracted	Teeth Sloping Mesially or Distally	Time Interval since Extraction	Collapse across Canine Width	Lower Appliance Worn	Whether Spacing of Upper Anteriors	Whether Extractions in Upper	Oral Hygiene
1	9 yr. 5 mth.	1	$\overline{2\|}$	$\overline{2\|}$	1 yr. 9 mth.	Nil	No	No	No	Fair
2	10 yr. 7 mth.	1	$\overline{\|2}$	$\overline{1\|12}$	1 yr. 2 mth.	Nil	Yes	Yes	No	Poor
3	9 yr. 5 mth.	1	$\overline{1\|}$	$\overline{1\|2}$	10 mth.	3 mm.	No	No	No	Fair
4	9 yr. 11 mth.	1	$\overline{1\|}$	$\overline{2\|2}$	9 mth.	2 mm.	No	No	Yes	Good
5	9 yr.	1	$\overline{\|1}$	$\overline{2\|2}$	4 mth.	1 mm.	No	No	Yes	Good
6	8 yr. 10 mth.	1	$\overline{1\|}$	$\overline{2\|2}$	6 mth.	—	No	Yes	No	Good

Group 2: Older children who present with gross irregularity of lower incisors (*Fig.* 2) and where long appliance therapy is contra-indicated, either because of lack of oral hygiene or the patient's lack of co-operation. (*Table II.*)

A demonstration given at the Bournemouth meeting held on May 6, 1961.

In the cases presented, certain facts present themselves and are worth noting:—

1. Without exception, all cases in Group 1 were of normal Angle Class 1 relationship, it being felt that any risk of collapse of the lower arch should be avoided in Class 2 cases.

2. An incisor, usually the most labial one, was only extracted if there was a definite mesial or distal slope of at least one of the adjacent teeth.

3. In the earlier cases, an appliance was fitted to control any collapse of the arch, but this is now not considered necessary. Only in 2 cases had an appliance to be fitted to move the remaining incisors into correct relationship.

A B

Fig. 2.—Patient aged 13 yr. 9 mth. A, Before extraction of $\overline{|1}$; B, Two years after extraction.

4. If there is not spacing of the upper incisor teeth before treatment, then compensation extractions of premolars in the maxilla are often necessary.

Table II.—Group 2

Case No.	Age	Angle's Classification	Teeth Extracted	Teeth Sloping Mesially or Distally	Time Interval since Extractions	Collapse across Canine Width	Lower Appliance Worn	Whether Spacing of Upper Anteriors	Whether Extractions in Upper	Oral Hygiene
1	12 yr. 8 mth.	I	$\overline{1\|}$	$\overline{2\|}$	1 yr.	2 mm.	Yes	Yes	No	Good
2	14 yr. 2 mth.	I	$\overline{4\|2}$	$\overline{2\|23}$	11 mth.	3 mm.	No	No	Yes	Good
3	13 yr. 9 mth.	I	$\overline{\|1}$	$\overline{2\|}$	2 yr.	Nil	Yes	No	No	Fair
4	11 yr.	I	$\overline{1\|}$	$\overline{2\|2}$	5 wks.	Nil	No	No	Yes	Good
5	12 yr. 6 mth.	I	$\overline{\|1}$	$\overline{\|2}$	2 yr. 1 mth.	2 mm.	No	No	No	Good
6	11 yr. 3 mth.	II, div. 1	$\overline{4\|1}$	$\overline{\|2}$	8 mth.	Nil	No	No	Yes	Fair
7	13 yr. 2 mth.	I	$\overline{\|2}$	$\overline{3\|3}$	1 yr.	5 mm.	No	No	Yes	Good
8	13 yr. 6 mth.	II, div. 1	$\overline{\|2}$	$\overline{3\|3}$	—	—	No	No	Yes	Fair
9	15 yr. 10 mth.	II, div. 1	$\overline{2\|2}$	Nil	3 mth.	6 mm.	Yes	No	Yes	Fair

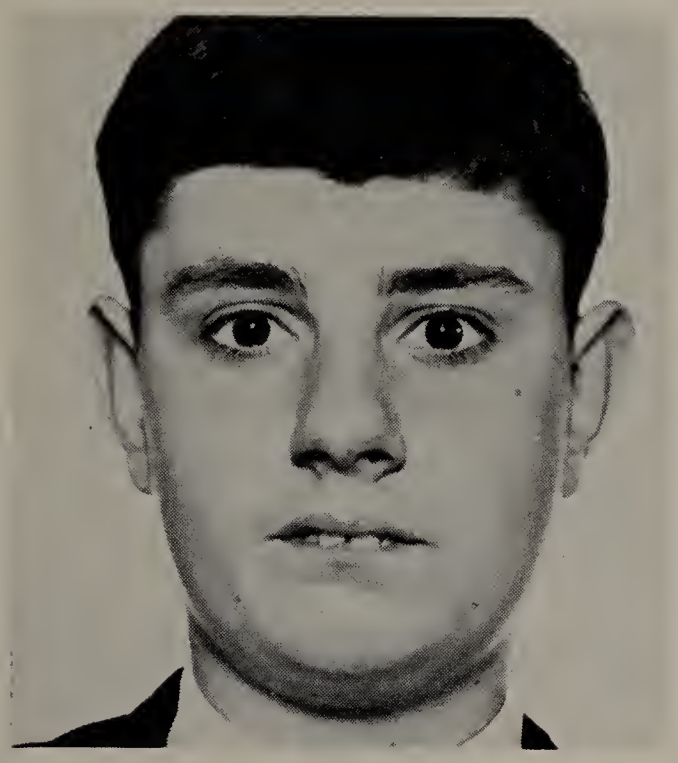
Acknowledgements.—Thanks are due to the Northern Group Hospital Management Committee for their co-operation in the presentation of this demonstration.

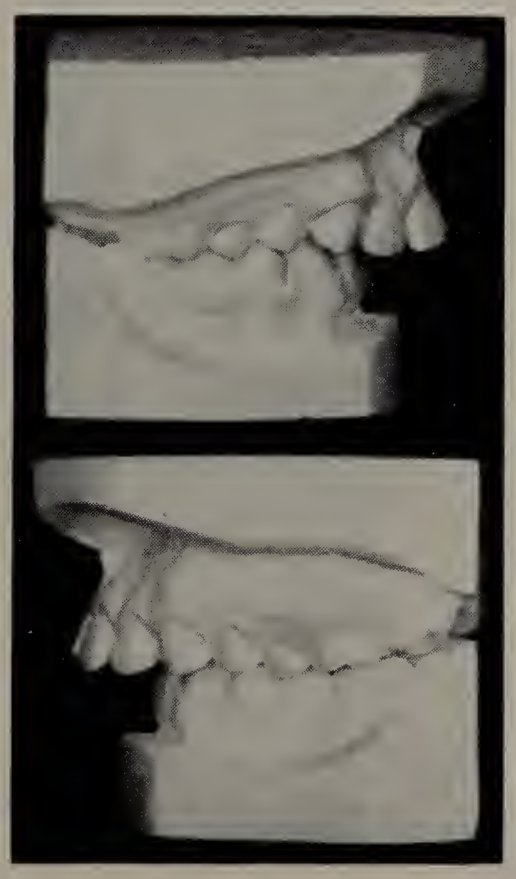
THE HEATH X PLATE

By **D. G. GOULD**, B.D.S., F.D.S., D.Orth. R.C.S.
Orthodontic Department, Eastman Dental Hospital

THE Heath X plate was developed by John Heath, sen., of Melbourne. It is a removable appliance which has been found useful in selected cases.

In his publications Heath has described the construction and use of the X plate in the treatment of Angle's Class I and Class II, division 1 malocclusions in the adult dentition and in the mixed dentition in conjunction with serial extractions. The present writer has used the X plate mainly in the adult dentition, but it was considered that a résumé of its indications and contra-indications in the treatment of Class II, division 1 malocclusions and a description of an ideal case would be of value.





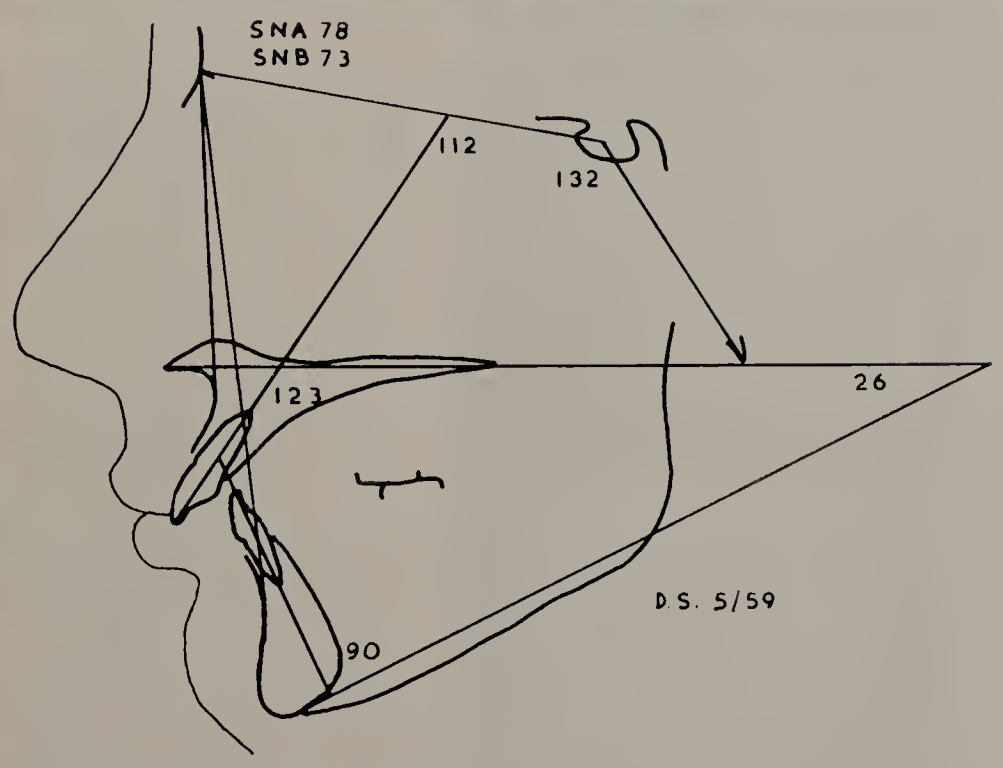


Fig. 1.—Before treatment. Full-face and profile photographs, models, and lateral skull tracing.

A demonstration given at the Country Meeting held at Bournemouth on May 6, 1961.

Principles of Action.—The appliance is fitted to the maxillary arch and is in two parts joined by special screws. In an Angle's Class II, division 1 type of malocclusion, in which the first premolars have been extracted, the appliance is constructed so that one part is attached to the incisors and canines and the other to the molars and second premolars. Activation of the screws moves the two parts together so that the incisors and canines will move distally and the molars tend to move mesially. The mesial movement of the molar segment is prevented by specially constructed bite-blocks attached to this segment, which

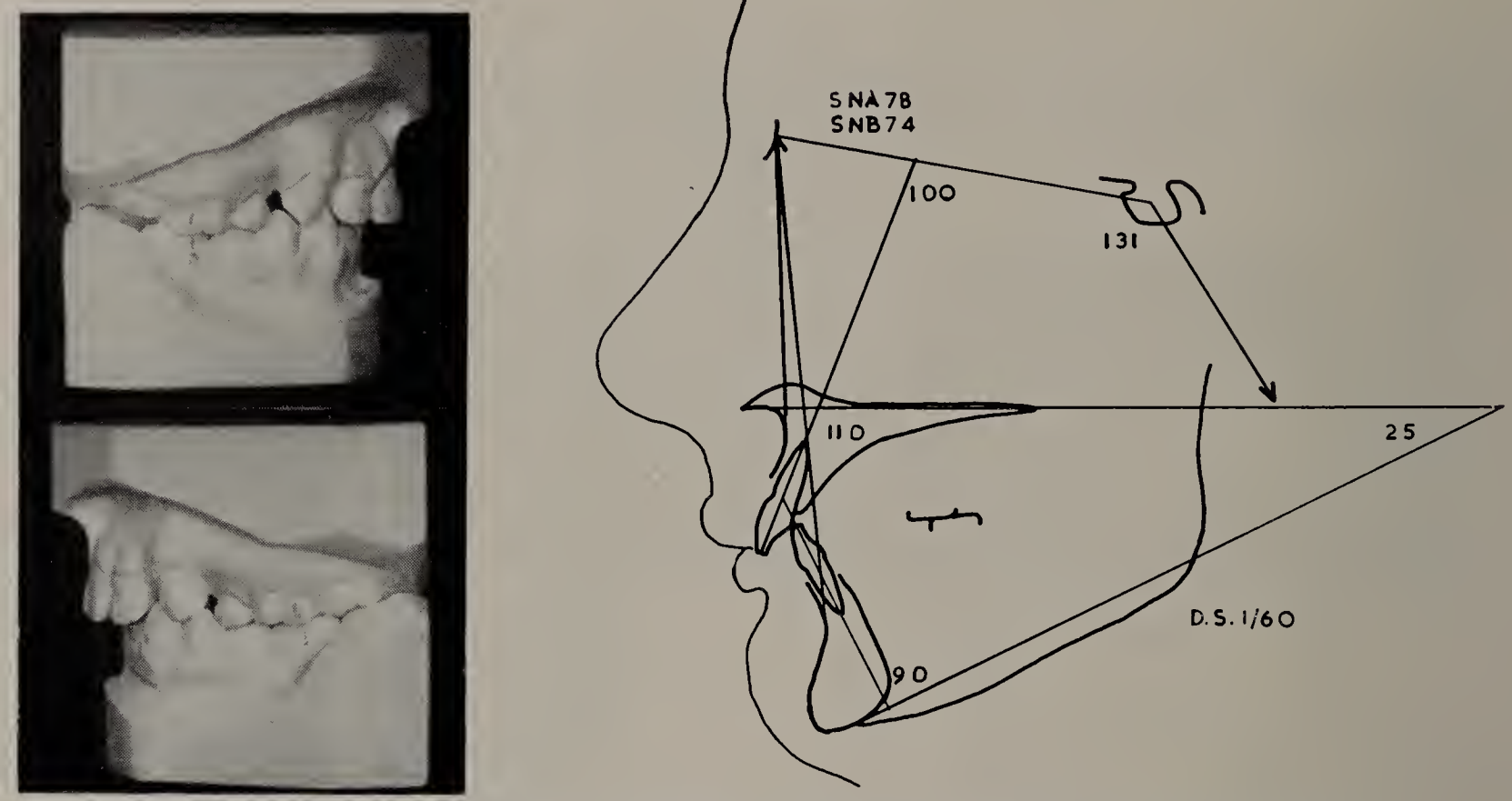


Fig. 2.—Models and lateral skull tracing after extraction of $\underline{4|4}$ and five months' treatment with Heath X plate.

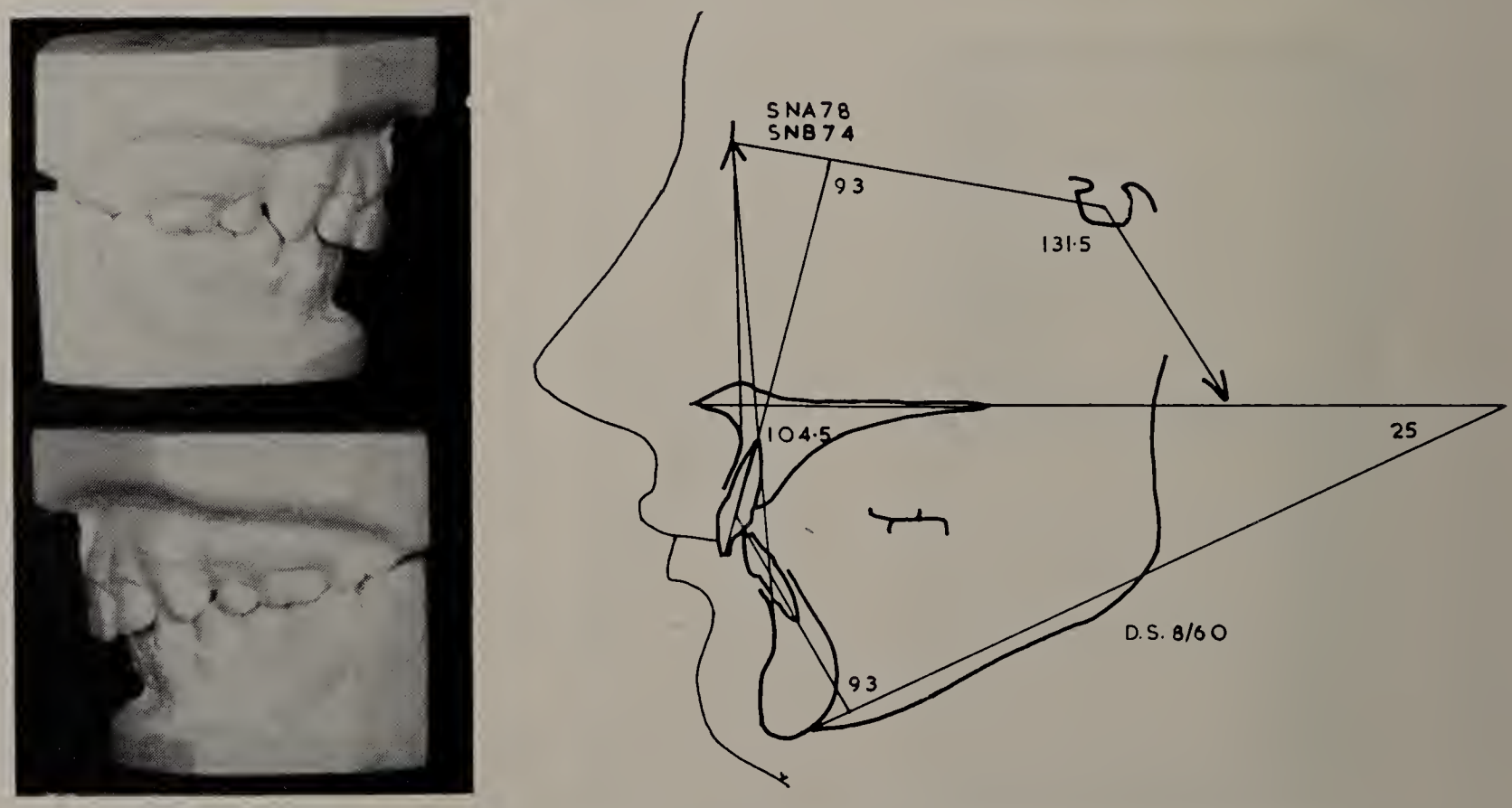
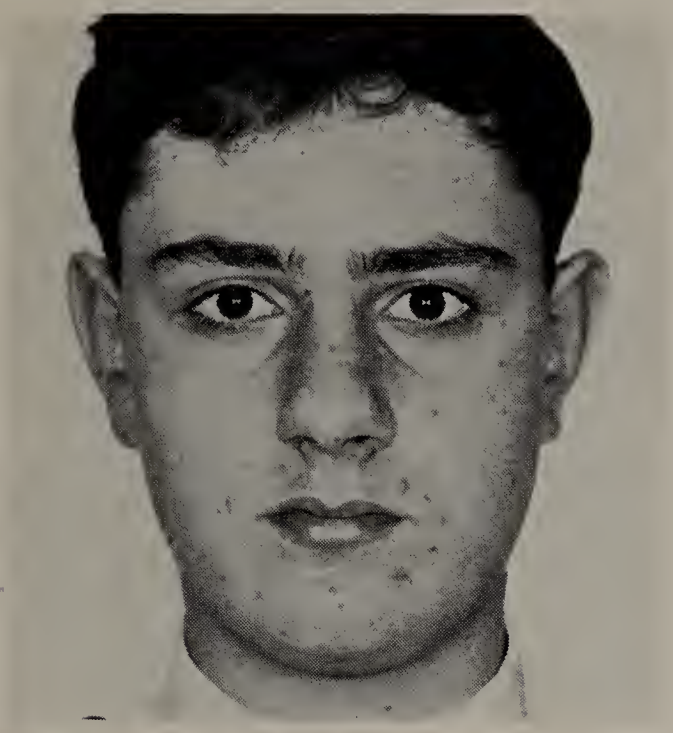
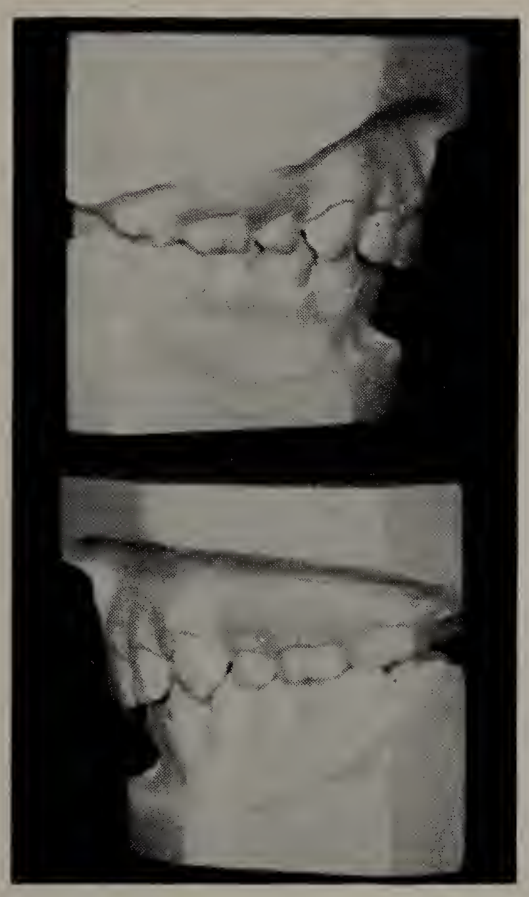


Fig. 3.—Models and lateral skull tracing after 11 months' treatment, when appliance was discontinued.

have recesses into which the mandibular teeth bite. As the mesial movement of the molars is prevented by the occlusion the main action of the appliance is to retract the incisors and canines.





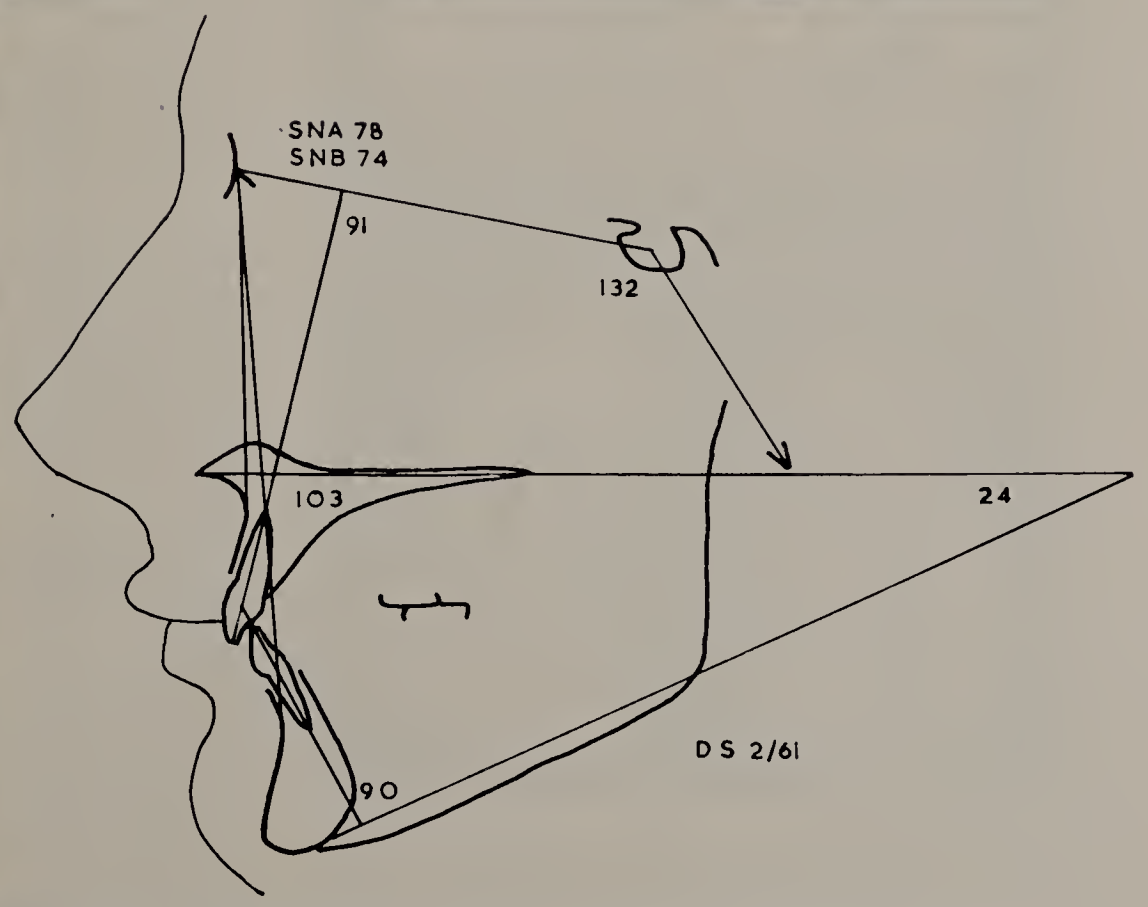


Fig. 4.—Full-face and profile photographs, models, and lateral skull tracing six months after end of appliance treatment.

Indications in Angle's Class II, division 1.—

1. Class I or mild Class II dental base relationship.

2. Maxillary incisors that are proclined in relation to the maxillary plane.

3. Maxillary incisors in reasonable alinement with no severely rotated or displaced teeth.

4. Complete, or nearly complete, overbite.

5. Mesial axial inclination of maxillary canines. Their relationship with the madibular canines can then be corrected by distal tilting around the apex.

6. Cross-bites in the molar region must have been corrected.

7. Soft-tissue patterns which are favourable for a stable end result once the incisor relationship has been corrected.

8. A continuous mandibular arch which is in reasonable alinement. Mandibular extractions can be carried out, but when the appliance is fitted the contact point relationships should be

continuous, or the adjustment of the screws will move the mandibular molars mesially and anchorage reinforcement will be negligible.

Contra-indications in the Treatment of Class II, division 1.—

1. A gross Class II dental base relationship.
2. A vertical relationship of the maxillary incisors to the maxillary plane such that palatal tilting of the crowns to reduce the overjet would produce an unsightly palatal inclination of the maxillary incisors.
3. Severely rotated or malpositioned teeth.
4. Vertical maxillary canines.
5. Severe, anteroposterior crowding of the maxillary arch, shown by distal axial inclination of the molars. In such cases the molars will move forward in spite of anchorage reinforcement.
6. Anterior open bite.
7. Severe imbrication of the mandibular incisors and canines, which, in the final results, interferes with the alinement of the maxillary incisors.
8. A break in the continuity of the mandibular arch.

Advantages of the Heath X Plate.—

1. Rapid and positive action.
2. Minimum of supervision is required.
3. In the periods between visits the appliance is continuously active and is therefore suitable for patients who can attend only at long intervals.
4. Patient participation leads to improved co-operation.
5. The anchorage of the maxillary molars and premolars is reinforced by the occlusion.
6. Only worn in evenings and at night.
7. Can be used in the mixed dentition.
8. May be used in reverse to correct a Class III incisor relationship.

Instructions to the Patient.—Patients tolerate the X plate well and very little difficulty will be experienced due to discomfort. It is wise to give the patient careful instructions at the first visit:—

1. Wear appliance every night in bed and whenever doing homework, reading, or watching television.
2. Turn screws in the direction of the arrow every other day.
3. Clean appliance carefully with a nail brush and warm soapy water. Do not use chlorine-containing denture cleansers, as they attack the screws.
4. If unable to wear appliance due to illness, do not turn the screws but start wearing appliance again as soon as possible.

Case Report.—*Figs.* 1–4 illustrate the treatment of an ideal case. The features which make this an ideal case are:—

1. Dental base relationship is slightly Class II.
2. Maxillary incisors are proclined at 123° to maxillary plane (average 109°).
3. No severely displaced or rotated teeth.
4. Overbite nearly complete.
5. Canines mesially inclined.
6. No cross-bite.
7. A good mandibular arch.
8. The posture of the lips is such that, once the incisor relationship has been corrected, they will function labial to the incisors and maintain the reduced overjet.

Acknowledgements.—I am grateful to John Heath, sen., for his help in obtaining the special screws for the appliance and for all the information he has so willingly given; to Mr. S. Granger McCallin for introducing me to the appliance and for allowing me to publish the case; to Mr. N. M. Potter for the photographs; to Mrs. S. Wilson, Librarian to the Eastman Dental Hospital, for the references, to Mr. W. Johnson for constructing the appliances; and to Miss J. Jeffery for typing the manuscript.

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PRE-SURGICAL DENTAL ORTHOPÆDICS

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NORMALLY the facial bones are supported against the pressure of the lips and cheeks by the buttressing action of the hard palate. When there is a complete unilateral or bilateral cleft of the lip, alveolus, and palate, however, the segments of the upper jaw, being no longer joined together, are free to move should any force act on them.

A distortion in the shape of the upper arch and an associated displacement of the segments can therefore occur due to: (1) An abnormal balance of muscle forces; (2) The direction of the growth of the cartilaginous nasal septum becoming modified.

ABNORMAL BALANCE OF MUSCLE FORCES

This may be considered under three headings:—

1. There is a reduced inwards pressure due to the cleft lip. Also the pull of the divided lip tends to widen the cleft anteriorly and causes a deviation of the centre line to the unaffected side.

2. The tongue going up into the cleft forces the segments apart and may prevent the margins from growing together should any growth potential be left.

3. The divided soft palate renders the tensor palati muscles ineffective, and allows the lateral pull of the pterygoid muscles to be unopposed.

These three factors therefore tend to displace the segments outwards, thereby widening the cleft and broadening the arch. The movement of the segments is around a fulcrum in the region of the zygomaticomaxillary suture. *Fig.* 1 compares the arches of a pair of 3-day-old identical twins. The twin with the cleft has a much wider arch than the normal one.

THE NASAL SEPTUM

In a bilateral case, the cartilaginous nasal septum, having lost its functional attachment to the buccal segments, is unrestrained and grows forwards like a snout bearing the premaxilla and prolabium. In a unilateral case it is still restrained on one side by the greater segment and it therefore swings over to that side causing a deviation of the centre line. This deviation is also associated with the unequal muscle pull already mentioned, due to the cleft lip. The lesser segment, having lost its functional attachment to the nasal septum, is no longer carried downwards and forwards by the growth of that structure and is considered by some authorities to lag behind in consequence. The growth of the general facial

Fig. 1.—Uniovular twins aged 3 days. The arch with the complete cleft lip, alveolus, and palate is wider than the normal.

A demonstration given at the country meeting held at Bournemouth on May 6, 1961.

musculature may compensate to some extent for this, but nevertheless it is reasonable to suppose that some retroposition of the lesser segment remains. *Fig.* 2 shows the distortion occurring in unilateral and bilateral cases in diagrammatic form. To summarize, therefore,

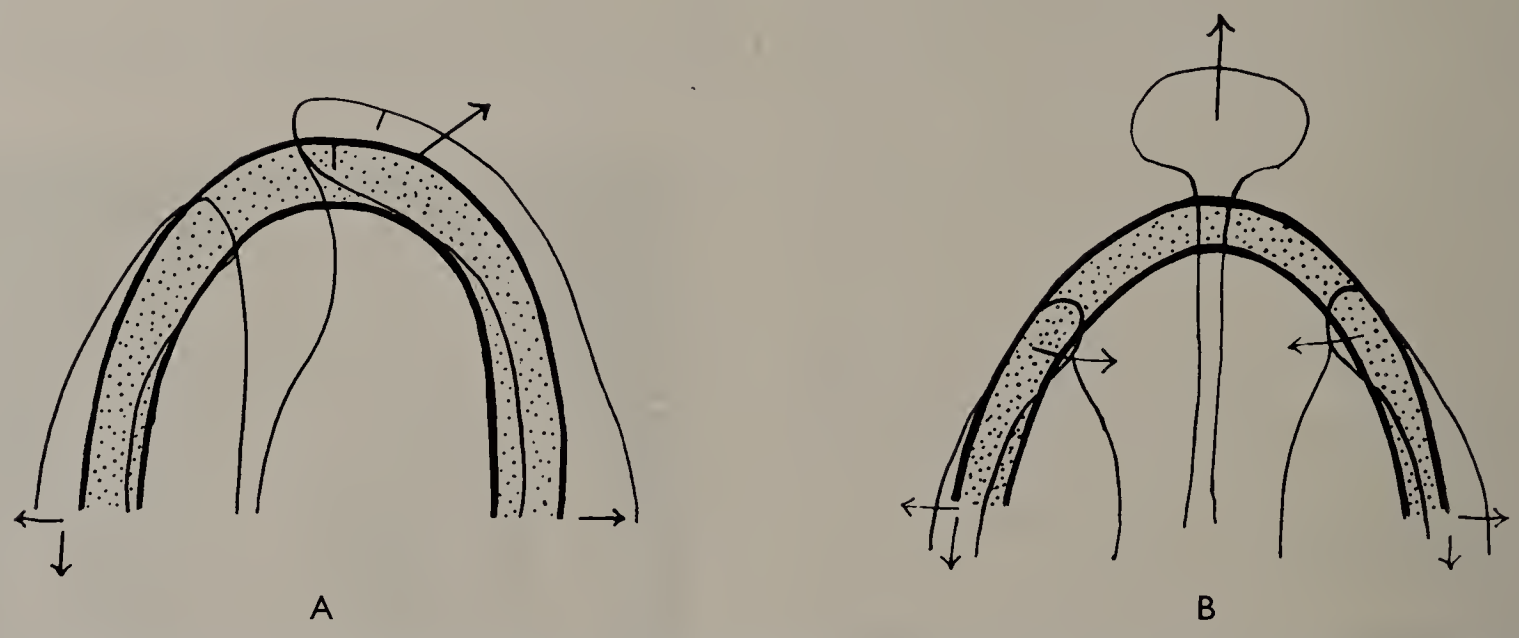


Fig. 2.—A, Diagrammatic representation of the distortion occurring in an arch with a complete unilateral cleft lip and palate. The arch is wider posteriorly and the centre line is displaced to the unaffected side. The position of the front end of the lesser segment is variable. B, Diagrammatic representation of the distortion occurring in an arch with a complete bilateral cleft lip and palate. There is protrusion of the premaxilla and possibly some retrusion of the buccal segments. The arch is wider than normal posteriorly, whilst the position of the front ends of the buccal segments is variable.

Fig. 3.—Wax bite. The bite-rim is constructed in soft wax to facilitate the registration of the lower gum pad in it. The anterior portion between the wings is left clear to make feeding easier when the finished appliance is worn.

the untreated cleft lip and palate case shows: (1) The basic cleft lesion with perhaps an associated deficiency of tissue. (2) A secondary displacement of the segments and distortion of the arch tending to widen the original cleft and broaden the arch in most cases.

The orthodox treatment for these cases is to repair the soft tissues surgically and then to rely on the new balance of forces established to reduce the displacement of the bony segments.

Usually the lip is repaired at 3 months, at which age the segments are still relatively mobile, whilst the palate is closed between 1 and $2\frac{1}{2}$ years of age, depending on the views of the surgeon concerned. There are several disadvantages associated with this:—

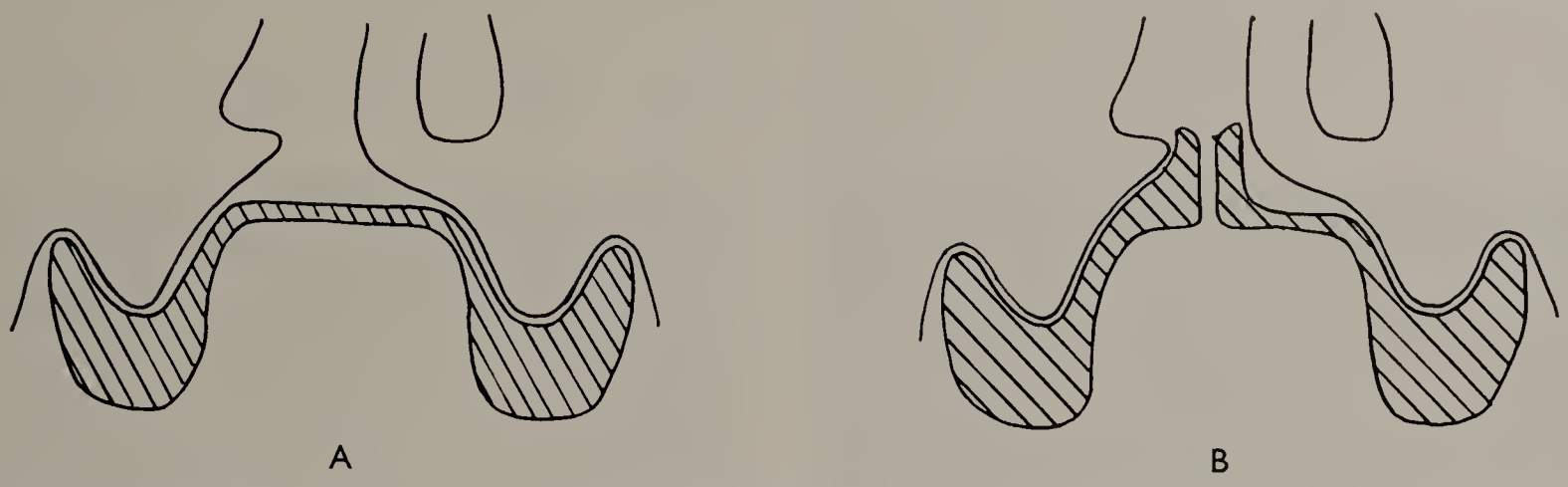
1. It is very difficult to control the final position of the segments once they start to come together and their final alinement may be very unsatisfactory. This is shown by the typically contracted arches found in the older cleft-palate cases.

2. The early lip repair tends to interfere with the growth of the upper jaw rather more than if the operation were performed later.

3. In bilateral cases some surgical techniques, although satisfactory immediately after operation, reduce the forwards growth of the nasal septum, giving a retroposed premaxilla later.

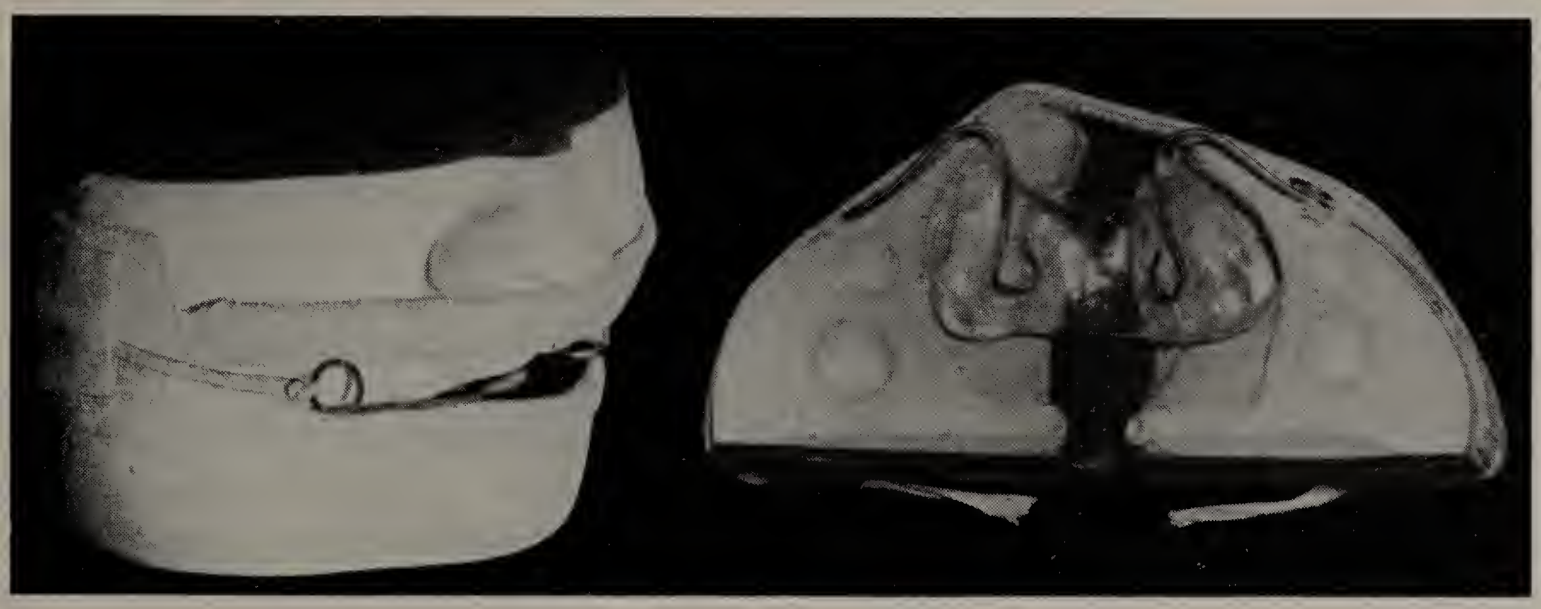
4. Because of the preoccupation of both surgeon and parents with the repair of the cleft, general dental care is often deficient. Orthodontic treatment may therefore have to be palliative, the final solution being a denture which also serves as an obturator if any residual fistulæ are present.

Reeently a new form of treatment has been developed by Dr. Kerr MeNeil of Glasgow (1954), and later by Dr. W. R. Burston of Liverpool (1958), whieh has been given the name "presurgieal dental orthopædies" (Glass, 1959).



A B

Fig. 4.—A, Diagrammatic representation of a coronal section through a cleft palate with the pre-surgical appliance in situ. The plate is well clear of the nasal septum and the cleft margins. Note how it is built up over the gum pads and extends well into the buccal sulcus. B, Modified pre-surgical appliance in situ. This type is now used exclusively and it extends into the cleft to obtain more control over the lesser segment. The septal area is still well relieved, however. The plate is also split down the midline and the two halves joined by an "omega" spring posteriorly.



A B

Fig. 5.—A, Model showing the plate and strapping being worn. The strapping is changed each day whilst the plate is worn continually and only removed after feeds for cleaning. B, Plan view of the plate and strapping being worn.

The prineiple of this is to reduee any displaeement present and to re-aline the segments before surgieal repair of the soft tissues is earried out. Critieism has been direeted against it, however, on the grounds that: (1) No long-term benefit to the patient has been proved. (2) Too mueh elinieal time is required in relation to any benefit obtained. (3) Treatment is too eomplex to be undertaken anywhere exeept in speeial elinies.

When this treatment was started on an experimental basis in the Birmingham region it was not possible to ereate a speeial unit, and the regional orthodontie elinies had therefore to be used instead for this purpose.

Treatment was originally based on the teehnique outlined by Burston (1958). A "paribar" impression was taken using a plastie aluminium tray and a working-model east. If this was not satisfaetory a speeial tray was then made and a new impression taken. On the working model the margins of the eleft and the nasal septum were thoroughly plastered out and a wax bite made (*Fig.* 3). This was built up with soft bite wax round the periphery to form a bite-bloek and also had a pair of wax wings whieh fitted outside the eheeks when it was worn (*Fig.* 3). The jaw registration was then taken by allowing the infant to bite into the soft bite wax and groove it with the lower

gum pad. The position of the wax wings in relation to the cheeks was also checked, and the bite then sent to the laboratory for final finishing and processing. When completed, the plate was inserted and a piece of tape tied through a hole at the end of each wing. The other end of this was fastened on to the cheek just in front of the ear with a piece of sticking plaster to prevent the infant pushing the plate out with its tongue (*Fig.* 4 A). When possible the appliance was inserted before the child was a fortnight old because: (1) At that age it accepted the plate without question. (2) The earlier treatment is started the better the result usually obtained.

The appliance was worn continually and only taken out after feeds for cleaning purposes. The mother was usually made responsible for looking after the plate as soon as possible, although in the very early stages it was done by the nursing staff.

Three or four days after the plate was inserted, when the child had grown used to it, external elastic strapping was applied. This was stretched across the upper lip and stuck to the cheeks on either side just in front of the ear (*Fig.* 5 A). Its purpose was to mould the front ends of the segments together (*Fig.* 5 B) and in bilateral cases to reduce the prominence of the premaxilla. At this stage the plate simply supported the segments and prevented them being collapsed inwards by the strapping. After two or three weeks, however, arch alinement was begun. A new impression was therefore taken and a model cast. This was cut down the line of the cleft and the segments then moved to bring them more nearly into line. The two halves were plastered together in this position to constitute the new working model. As before, a bite was taken and the plate then finished and processed. When first inserted this plate did not fit properly, but gradually as it settled into place, due to the lower gum pad biting against it, the segments moved until they corresponded to the appliance.

The segments having been partially alined, another plate was then required to continue the process. Each patient therefore required several appliances during the course of treatment. In addition to alining the arches, the plates were also used to stimulate the palatal mucosa to make the cleft margins grow together. This was done by making the appliance exert an intermittent pressure on the palatal mucosa about 1 mm. away from the margins of the cleft.

ADAPTATION TO REGIONAL CONDITIONS

When the child was old enough, treatment was usually carried out at the nearest orthodontic clinic. Prior to that, however, special visits were necessary by the orthodontist to the maternity hospital and to the home. This involved considerable travelling, and the technique was therefore modified to reduce these special visits to a minimum without the appliances losing their efficacy.

1. A selection of prefabricated trays was used to obtain a good working impression at the first visit.

2. The bite stage was eliminated, and the plate built up posteriorly on either side in an arbitrary manner.

3. Because there was no bite stage, the acrylic wings could not be adjusted accurately. These were therefore replaced by 1·25-mm. stainless steel wires which were bent to shape and fitted at the time of insertion (*Fig.* 6).

4. Instead of the first plate only being used to prevent the segments collapsing under the pressure of the strapping and to assist feeding, arch alinement was begun immediately. The external strapping was also applied at the time of insertion instead of a few days afterwards.

5. The amount of supervision was also reduced, the plate being inserted, the strapping applied, and the patient seen one week later. If at that stage everything was satisfactory the appliance was checked at three- to four-weekly intervals.

6. The plates were no longer made to stimulate the palatal mucosa, because the cleft of the hard palate reduced in width whether this was done or not. Care had also to be taken not to allow the palatal cleft to become too narrow, as this tended to restrict access when the surgeons were endeavouring to close the floor of the nose.

7. The plates were cut down the midline and the two halves joined by an "omega" spring of 1·0-mm. wire at the back (*Fig.* 7). This allowed the segments to be alined without having to use a series of plates. Usually the front end of the lesser segment, or both buccal segments in a bilateral case, tended to swing inwards under the pressure of the strapping, but the split plate hinged at the back allowed this to be counteracted and the front end of the segments moved out instead. Usually only one appliance is now required before lip repair.

Fig. 6.—Pre-surgical appliance with wings constructed from 1·25-mm. stainless steel wire. This is neater than the acrylic type and the wire should be adjusted to just press on the cheeks to help stabilize the appliance.

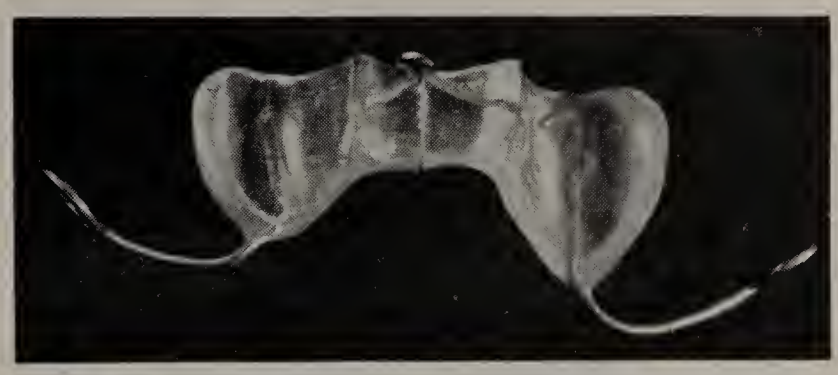


Fig. 7.—Split plate with "omega" spring. Usually only one such appliance is necessary before the lip is repaired. The "omega" spring is of 1·0-mm. stainless steel wire and the plate is extended into the cleft to allow a better purchase on the segments to move them more efficiently.

8. To make it more efficient the appliance was extended up into the cleft to allow it to obtain a better purchase on the segments when swinging them out (*Fig.* 4 B). Despite this the reduction in the width of the palatal cleft during pre-surgical treatment still occurred, but instead of growing directly towards each other, the cleft margins grew upwards and then inwards over the top of the plate.

The lip was usually repaired by the surgeon at about 6 months of age because little improvement occurred if the pre-surgical treatment was continued beyond this age. Furthermore, after about 9 months it became progressively more difficult to make the baby wear the appliances. In certain cases lip repair was postponed until about 12 months and the lip and palate were then repaired simultaneously. This tended to avoid the residual fistula sometimes seen at the anterior end of the hard palate. In the original technique, a plate was inserted after lip repair to prevent the segments collapsing. It was found in our cases, however, that the baby would often refuse to wear this appliance but, even so, no collapse occurred. Pre-surgical treatment is now therefore stopped after lip repair, and the infant merely kept under observation as its occlusion develops.

CASE REPORTS

Over 50 cases have now received pre-surgical treatment, but because those to be described were the first four, the treatment given was slightly more elaborate than is now usual. The differences in the treatment may be summarized as follows:—

1. More than one appliance was worn up to the stage of lip repair.

2. The appliances were of the type shown in *Figs.* 4 A, 5, and 6. The plates were not split and did not extend into the cleft. There was no attempt to "stimulate" the palatal mucosa to make the cleft margins grow together.

3. Although appliances were inserted after lip repair, these were not worn constantly and appeared to be without effect. No attempt was made to fit appliances after palate repair except in *Case* 3.

Case 1 (*Fig.* 8).—Paul W., born Oct. 1, 1959. Complete bilateral cleft lip and palate with considerable protrusion of the premaxilla (*Fig.* 8 D). First appliance was inserted on Oct. 21, 1959, and strapping was begun on Oct. 24. Three appliances were made over a period of $5\frac{1}{2}$ months before the lip was repaired. The protrusion of the premaxilla was reduced considerably and there was also some reduction in the width of the palatal clefts. Slight collapse of the buccal segments occurred, but not enough to account for the reduction in the width of the palatal clefts. The lip was repaired in one stage by Mr. J. North on March 24, 1960 (*Fig.* 8 E). The residual notch in the midline is indicative of the shortage of tissue

in the premaxilla. Wearing of the appliance to prevent collapse of the buccal segments was started again 14 days after operation, and a new plate to expand the segments was inserted on April 20. *Fig.* 8 F shows an impression taken on July 27. Another appliance was fitted on Aug. 3 to continue the expansion. Pre-surgical treatment, however, appeared to have little effect on the segments after lip repair. The palate was repaired in November, 1960, and a study impression taken on Dec. 7 (*Fig.* 8 G). An impression taken on April 19, 1961, is shown in *Fig.* 8 H. A residual fistula is present anteriorly which should reduce in time. Some collapse has occurred at the anterior end of the buccal segments, but the premaxilla has been reduced until it contacts the buccal segments. The palatal cleft was reduced by approximately 19 per cent before surgical closure. Prior to the preoperative treatment being commenced, concern was expressed over the shortage of tissue in the premaxilla and its considerable prominence. The prognosis for a purely surgical closure of the lip was considered poor.

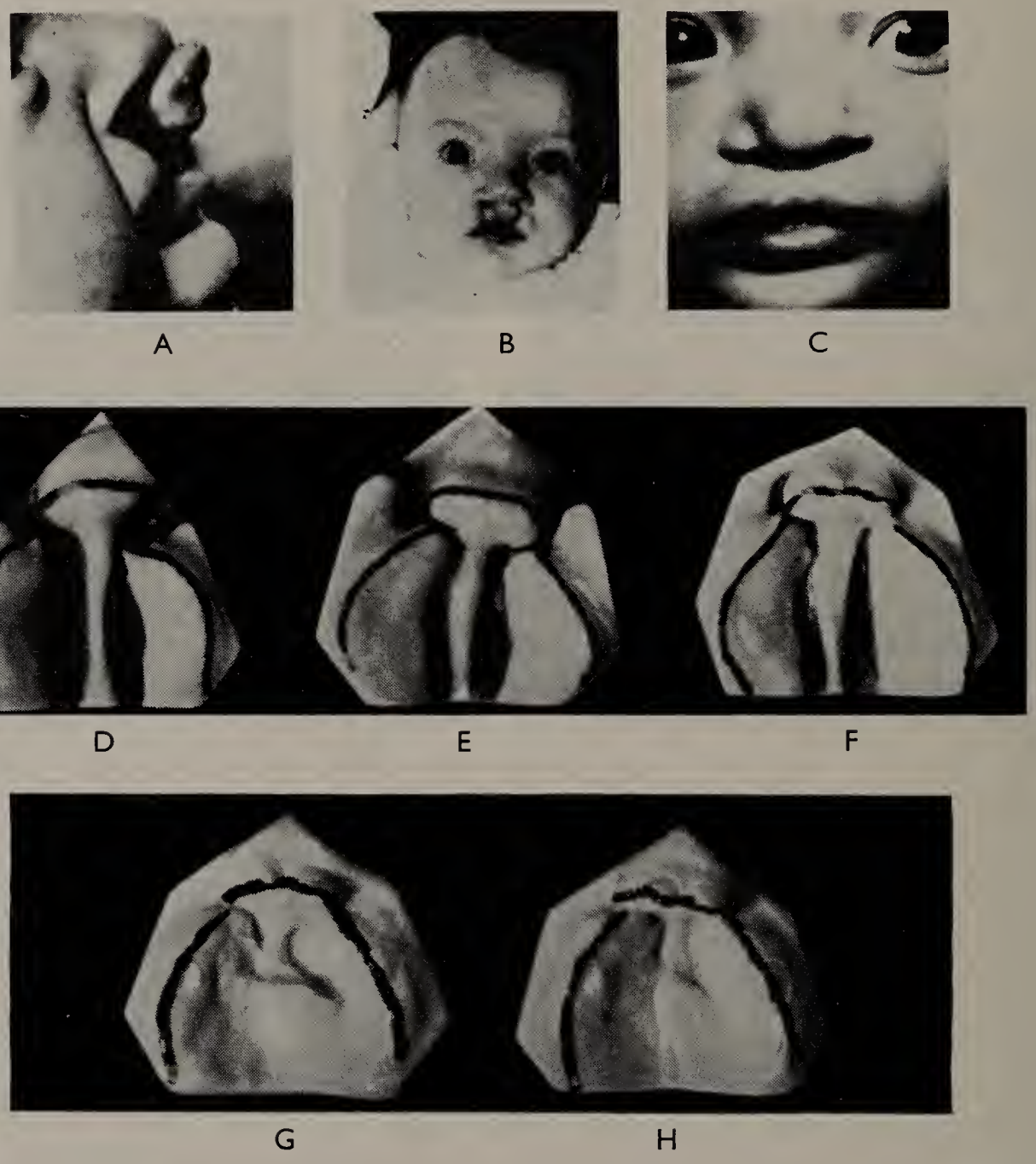


Fig. 8.—*Case* 1. Paul W., born Oct. 1, 1959. A, Photograph taken on Oct. 21, 1959; B, Photograph of pre-lip repair; C, Photograph of post-lip repair. D, Model on Oct. 21, 1959; E, Model on March 24, 1960; Lip repair March 24; F, Model on July 27; Palate repair Nov., 1960; G, Model on Dec. 7; and H, Model on April 19, 1961. No appliances were worn after palate repair.

Case 2 (*Fig.* 9).—Mark M., born Nov. 1, 1959. Complete cleft of left lip, alveolus, and palate (*Fig.* 9 D). Partial cleft of right lip and soft palate. The first appliance was inserted on Nov. 6, 1959, and strapping was commenced on Nov. 10. Four appliances were made over a period of 6 months. The segments of the upper arch were alined satisfactorily with only slight collapse of the lesser segment. There was also good reduction in the widths of the palatal and alveolar clefts (*Fig.* 8 E). Lip and palate were repaired simultaneously on May 31, 1960, by Mr. O. T. Mansfield, but the partial cleft of the right lip was not touched. No appliances were worn afterwards. Study models (*Fig.* 9 F) and photographs were taken 3 months later on Aug. 22, 1960. The case is now being left under observation as the occlusion develops. So far, following a slight contraction after operation, the upper arch has stayed stable.

Case 3 (*Fig.* 10).—Ian B., born Dec. 3, 1959. Complete unilateral cleft of lip, alveolus, and palate (*Fig.* 10 D). The first appliance was inserted on Dec. 17, 1959, and strapping started immediately. Two appliances were made over a period of 6 months before the lip was repaired. Satisfactory arch alinement was achieved with reduction in the width of the palatal and alveolar clefts

(*Fig.* 10 E). The lip was repaired on June 20, 1960, by Mr. J. North, and an appliance to prevent the lesser segment collapsing was inserted 2 weeks later. *Fig.* 10 F shows an impression taken on July 29, 1960. A further appliance was fitted on Aug. 3, 1960. The palate was repaired on Nov. 3, 1960. Impressions were taken 2 months (*Fig.* 10 G) and 5 months (*Fig.* 10 H) after palate repair. The posterior width of the arch has been reduced by about 3·4 mm. since palate repair, and 6·5 mm. since birth. |A is inside the bite, and an appliance was given to correct this but was not worn. A 100 per cent reduction of the alveolar cleft and a 53 per cent reduction of the palatal cleft were achieved before surgery. There may have been a true deficiency of tissue in the region of the alveolar cleft, allowing excessive moulding of the front of the arch to occur. This would account for the palatal position of |A in models shown in *Fig.* 10 G, H. As the father has a Class III malocclusion, however, the child may also be a Skeletal Class III case.

Case 4 (*Fig.* 11).—Brett W., born Jan. 27, 1960. Complete unilateral cleft lip and palate (*Fig.* 11 D). First appliance inserted on Feb. 4, 1960, and strapping started 2 days later. Three plates were made over a period of 6 months before lip operation (*Fig.* 11 E). Alinement of the lesser segment was satisfactory, but the moulding of the anterior end of the greater segment was not complete and a residual gap in the alveolar cleft was present prior to operation. The lip was repaired on July 27, 1960, and an appliance to prevent post-operative collapse of the lesser segment inserted on Aug. 8. A new plate was inserted on Oct. 6. *Fig.* 11 D shows the last model of the mouth (Dec. 8, 1960) before palate repair in December. No further plates have been worn. A 77 per cent reduction of the alveolar cleft and a 50 per cent reduction of the palatal cleft were achieved before surgery.

The case demonstrates the effect of the increase in external pressure due to the lip being repaired, the moulding of the front end of the greater segment being completed and the alveolar cleft eliminated. In the 4 months following palate repair some fall-in of the front end of the lesser segment has occurred. The posterior arch width is also reduced slightly.

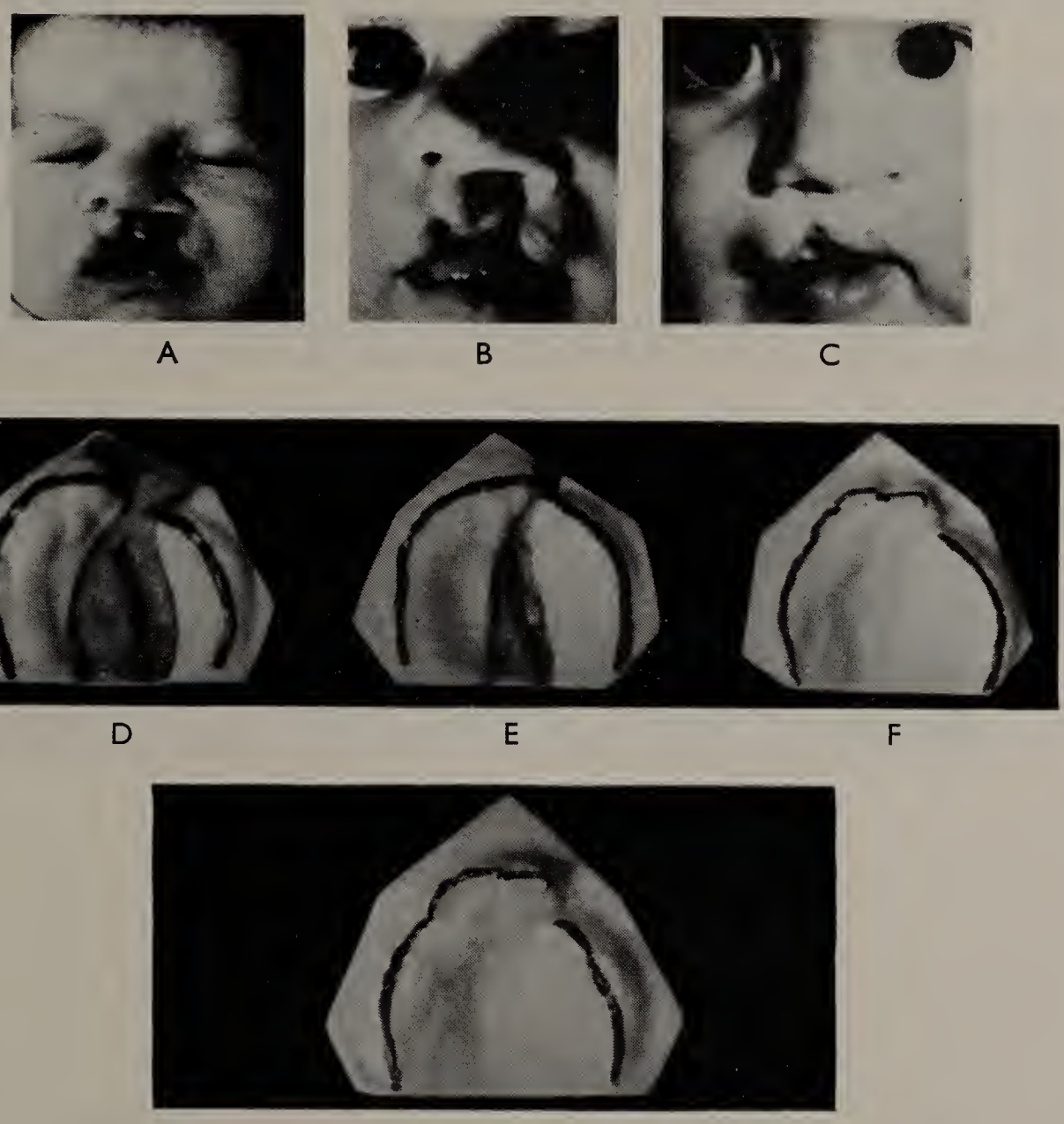


Fig. 9.—*Case* 2. Mark M., born Nov. 1, 1959. A, Photograph taken on Nov. 6, 1959; B, Photograph of pre-lip and -palate repair; C, Photograph of post-lip and -palate repair; D, Model on Nov. 6, 1959; E, Model on March 3, 1960; Lip and palate repair May 31; F, Model on Aug. 22; and G, Model on Jan. 14, 1961. No appliances were worn after repair of the lip and palate. Following the initial post-operative contraction the arch has remained stable. The partial cleft of the right lip has been left unrepaired and the question of repairing it will be considered when the patient is about 4 years old.

A B C

D E F

G H

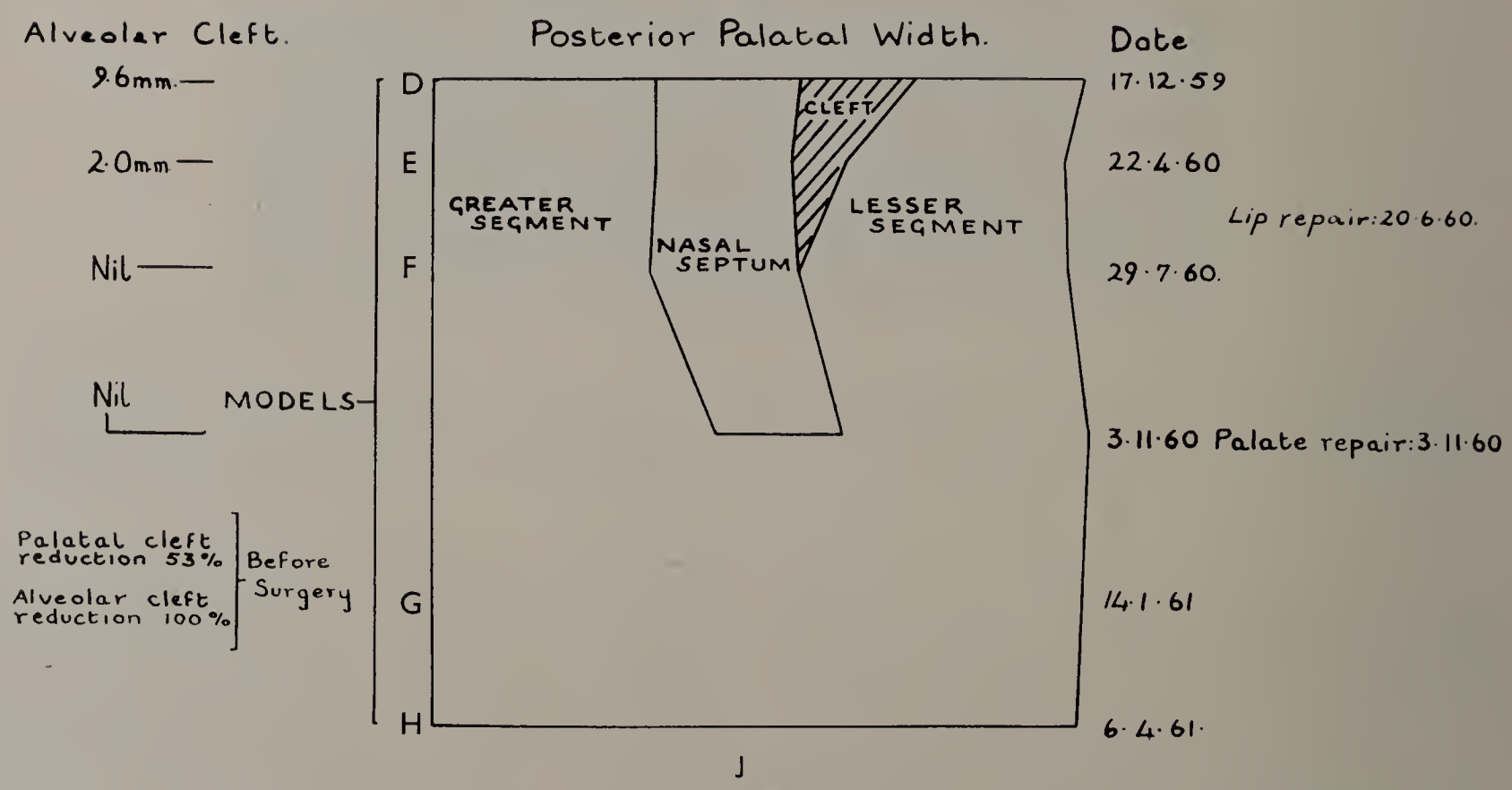


Fig. 10.—*Case* 3. Ian B., born Dec. 3, 1959. A, Photograph taken on Dec. 17, 1959; B, Photograph of pre-lip repair; C, Photograph of post-lip repair; D, Model on Dec. 17; E, Model on April 22, 1960; lip repair June 20; F, Model on July 29; palate repair Nov. 3; G, Model on Jan. 14, 1961; and H, Model on April 6. J, Diagrammatic representation of the changes in the posterior palatal width as treatment progressed. Both the greater and lesser segments increased in width although the arch width stayed fairly constant. The palatal cleft was reduced by half and the alvcolar cleft eliminated by pre-surgical treatment before lip repair.

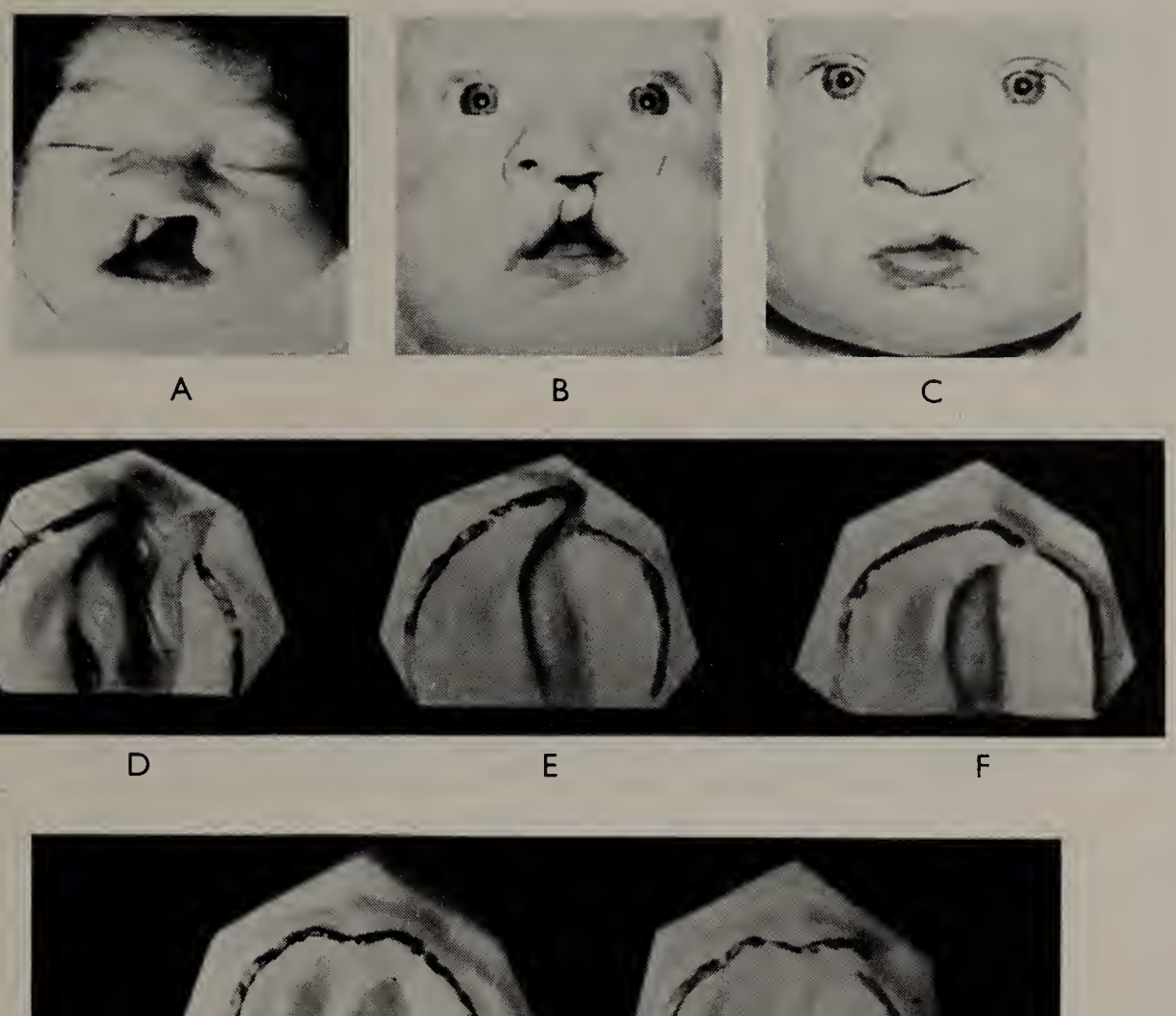
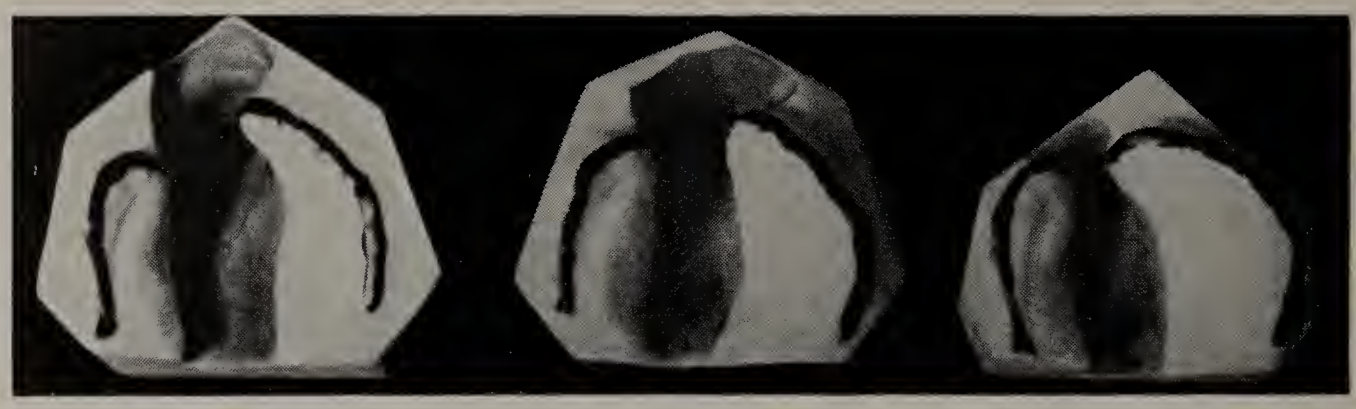


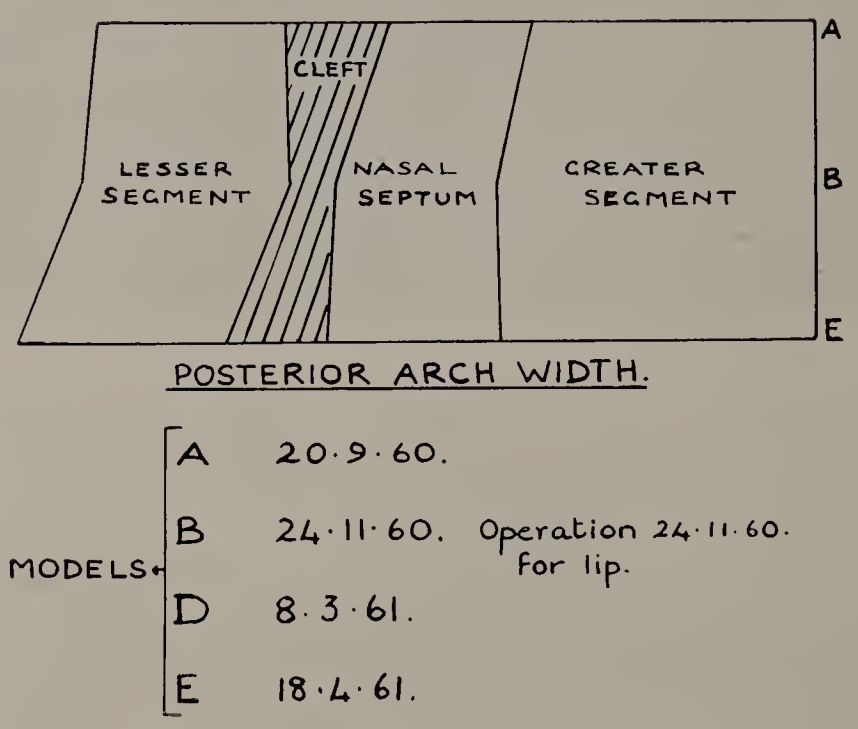
Fig. 11.—*Case* 4. Brett W., born Jan. 27, 1960. A, Photograph taken on Feb. 4, 1960; B, Photograph of pre-lip repair; C, Photograph of post-lip repair; D, Model on Feb. 4; E, Model on July 7; lip repaired July 27; F, Model on Sept. 19; G, Model on Dec. 8; palate repair Dec. 16; and H, Model on April 6, 1961. An appliance was inserted after lip repair but it was hardly worn. No appliance worn after palate repair. J, Diagrammatic representation of the changes in posterior palatal width as treatment progressed. Up to the stage of lip repair both the greater and lesser segments increased in width, although the arch width decreased slightly. There was rapid reduction in the width of the palatal cleft up to lip repair. The alveolar cleft was reduced by almost 10 mm. as a result of pre-surgical treatment.

Control Case (*Fig.* 12).—Patricia S., born Aug. 4, 1960. Complete unilateral cleft lip and palate (*Fig.* 12 A). The lip was repaired by Mr. J. North on Nov. 24, 1960, at the age of 14 weeks (*Fig.* 12 B). Some narrowing of the alveolar cleft occurred over the next two months (*Fig.* 12 C). Afterwards the position of segments became stable again (*Fig.* 12 D, E). The upper lip is rather slack and this may account for the absence of severe contraction of the upper arch so far. The residual alveolar cleft, however, could allow the lesser segment to fall in relatively easily behind the greater segment after palate repair. The main consequence of pre-surgical treatment is probably to



A B C

D E



F

Fig. 12.—*Control Case.* Patricia S., born Aug. 4, 1960. A, Model on Sept. 20; B, Model on Nov. 24; lip repair Nov. 24; C, Model on Feb. 2, 1961; D, Model on March 8; E, Model on April 18; F, Diagrammatic representation of the changes in the posterior palatal width with age. This became consistently greater and whilst there was some increase in the width of the greater segment, the lesser segment increased only slightly. The width of the cleft remained about the same.

bring the margins of the alveolar cleft together and therefore make it more difficult for the lesser to slip inside the greater segment later. This would be further helped by the late lip repair (6–9 months) because the segments would not then be so mobile.

RESULTS AND COMMENTS

In the unilateral cases the posterior arch width tended to stay the same or even decrease and there was a reduction in the width of the palatal cleft by approximately 40 per cent (*Figs.* 10 J and 11 J). The alveolar cleft was almost completely eliminated with the two margins in contact (*Figs.* 9, 10 A–H, and 11 A–H), but no evidence of *fusion* of the two margins was seen, as has been sometimes claimed when this type of treatment is undertaken. In the bilateral case both the prominence of the premaxilla and the posterior arch width were reduced. There was, however, a tendency for the anterior ends of the buccal segments to collapse inwards behind the premaxilla (*Fig.* 8).

In contrast to this the posterior arch width in the control case continued to increase whilst the width of the palatal cleft stayed constant. Some decrease in the width of the alveolar cleft occurred (*Fig.* 12).

It is only possible to speculate on the reason for the changes following pre-surgical treatment at the moment, but the following hypothesis could be suggested to account for them so far:—

1. In untreated cases, as general growth of the face and jaws proceeds and the upper arch becomes broader, the segments move farther apart. Although the margins of the cleft may be tending to grow together, therefore, no obvious narrowing of the palatal defect is observed.

2. The pre-surgical appliance minimizes the lateral growth of the upper arch (*Fig.* 4 A) and also excludes the tongue from the cleft. The cleft can now be narrowed therefore by oppositional growth of its margins.

3. The reduction of the alveolar cleft in a unilateral case occurs in two ways: (*a*) by appositional growth on the anterior margin of the lesser segments, and (*b*) by the anterior end of the greater segment being moulded round by the external strapping to correct the displaced centre line.

4. In bilateral cases the prominence of the premaxilla is reduced because the strapping prevents it growing farther forwards and allows the rest of the face, which continues to grow forwards, to catch up. If actual backwards movement of the premaxilla occurred, the nasal septum might be expected to buckle, and this only seems to occur in older cases where the neonatal growth spurt is subsiding.

Following palate repair at about twelve months a narrowing posteriorly of the upper arch occurred, with the anterior end of the lesser segment in unilateral cases tending to become slightly retroposed and to fall in a little behind the front end of the greater segment. The narrowing was probably due to the tensor palati muscles, which are joined across the midline during the repair of a soft palate, creating a new balance of forces with the pterygoid muscles. After palate repair and the initial contraction, the arches seemed to become stable again without any appliances being worn. Compared with cases treated normally, there appears to be less post-operative collapse when pre-surgical treatment has been undertaken. This is probably due to the later lip operation and to the butt joint frequently obtained between the margins of the alveolar cleft which gives some support to the segments in a transverse direction. A late lip operation by itself, however, may not mould the front end of the greater segment round enough to meet the front end of the lesser, without pre-surgical treatment.

It is far too early yet to evaluate the effect of the procedures on the growth of the jaws, but the following observations may be made:—

1. Because of the intensive freeing of the facial muscles necessary to obtain a tension-free lip repair, this operation is now thought to be responsible for much of the reduction in the forwards growth of the upper jaw following surgery. If the alveolar cleft is diminished by pre-surgical treatment, the need for this intensive freeing is reduced and there is consequently less periosteal damage incurred.

2. The lip repair, formerly done at 3 months, is now carried out at 6 to 9 months or even later.

In both cases it would appear that any disturbance of future growth by surgery is likely to be minimal if pre-surgical treatment is carried out. There are two advantages of pre-surgical treatment which have already become apparent, however. The appliances greatly aid feeding, especially when the babies are very young. In most cases, with the appliances in place, the infants can be bottle-fed using an ordinary teat and a slightly enlarged hole. The children usually squirt the milk out by compressing the teat with their tongues and lower gum pads against the palatal portion of the plate instead of sucking. Feeding becomes quicker and less exhausting, and the child in consequence is better nourished. This is in marked contrast to the situation previously when the children had to be spoon-fed and often were so underweight and anæmic that they needed hospitalization before they were fit enough to withstand operation.

Mothers find the early start to treatment a great comfort and welcome the opportunity to discuss their children's treatment with someone directly connected with the plastic unit. Post-natal depression has been much reduced, and in over 50 cases no child has been rejected by its parents. The importance of this must not be underestimated.

Acknowledgements.—I wish to acknowledge my indebtedness to the Research Subcommittee, Birmingham Regional Hospital Board, for financial assistance and to Mr. O. T. Mansfield, F.R.C.S., Director of the Regional Plastic Unit, Wordsley Hospital, and his colleagues for their help and encouragement; also to Mr. Moore, of the Dental Laboratory, Wordsley Hospital, for constructing the appliances and demonstration models, and Miss M. Robertson for the illustrations.

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MODIFICATIONS OF APPLIANCE DESIGN

A CLASP FOR REMOVABLE APPLIANCES

By **NORMAN J. WOOD**, L.D.S., D.Orth. R.C.S.

It was considered that the various forms of modified arrow-head clasp in general use were not entirely satisfactory, for the following reasons:—

The efficiency of these clasps depends mainly upon the depth of the crown of the tooth, and unless this is adequate it is difficult to adjust the clasp without impingeing upon the gingival margin. It is also difficult to keep the wire flat across the interproximal space, with the result that it is broken when bitten on. Other causes of breakage are the sharp bends which have to be made in the construction of the clasp, and the fact that the clasp cannot be satisfactorily made in wire of larger than 0·7-mm. gauge, a still smaller gauge being required for deciduous teeth.

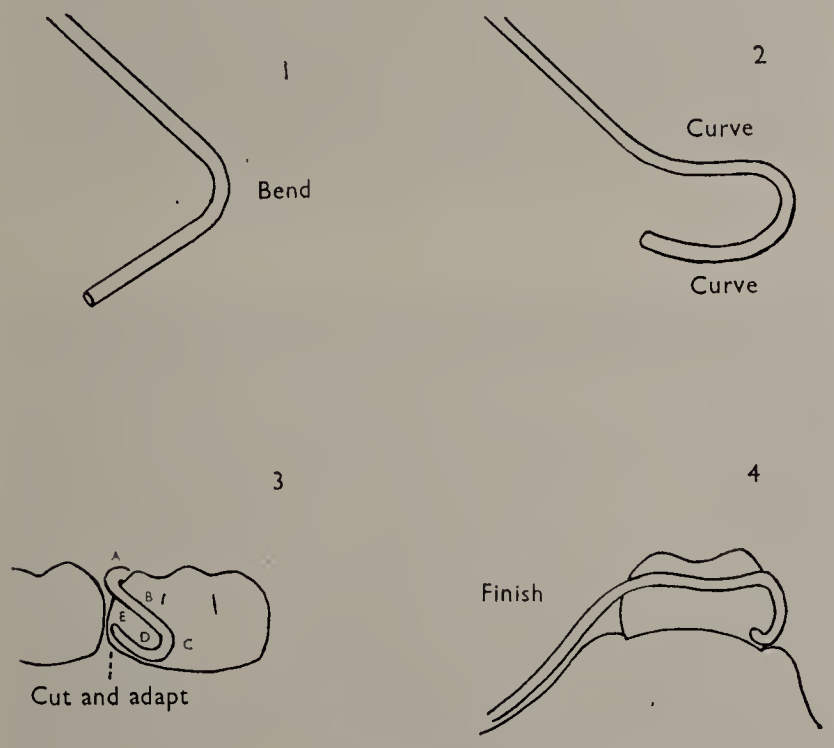

Fig. 1.—Stages in the construction of the clasp.

The clasp demonstrated was designed to overcome these drawbacks, and it will be seen that although it also makes use of the mesiobuccal and distobuccal undercuts it does so from a more horizontal approach.

Fig. 1 shows stages in the construction of the clasp. It is made in 0·9-mm., 0·8-mm., or sometimes 0·7-mm. wire, and is fitted closely over the interproximal contact point. Section ED engages the retention area, and although it is not strictly necessary that section B should touch the tooth, it is useful to make it do so if it is desired to prevent tipping of the tooth clasped. Adjustments are made at points A, C, and E. There are no projections to irritate the cheeks or lips. The clasp can be used on all molars, premolars, and canines, and in conjunction with a Visick-type pin on the mesiopalatal surface of a very sloping upper molar. The pin should be of light wire, so as to have some springiness, and should extend only to the gingival margin. Retention will be found effective even on a lower molar with a shallow crown, and a pin on the lingual surface is unnecessary.

Fig. 2.—An upper removable appliance, showing clasp arrangement and labial arch.

Fig. 2 shows the clasps incorporated in an upper removable appliance. Attention is also drawn to the use of a simple coil in the labial arch instead of the conventional U loop, which is liable to breakage after repeated adjustment. The tension in the arch wire can be adjusted within the coils. It is not claimed that the labial arch is thereby made more effective as a

A demonstration given at the Country Meeting held at Bournemouth on May 6, 1961.

retracting agent, and light auxiliary springs are added if substantial retraction is desired.

The free end of the canine retractor is curled over in a hook-shape which clips into the interproximal space. This also keeps the retractor in position, the conventional type of ending often being rejected by the shape of the tooth and forcing the plate away from the palate. This hook-type of ending is also used when premolars or incisors are to be moved and there is no space between the teeth. When space has been made the hook ending is flattened down.

Fig. 3 shows an appliance with retention clasps on the deciduous teeth. The retention clasp on the central incisors is useful for holding up the front of the plate, when for instance the lateral incisors are being moved, or for holding down the front of a lower appliance. The wire is 0·9-mm. or 0·8-mm. gauge, and is not sprung against the teeth, but is adapted closely to the tooth surface and into the embrasures at the cervical margins of the mesial surfaces of the teeth. Wire of 0·8-mm. or 0·7-mm. gauge is used for the lower incisors, either a single clasp or a pair being used.

Fig. 4 shows the clasps on a lower model.

Fig. 5 shows the clasp arrangement for an upper appliance. This arrangement is also useful when space behind the canine is limited, as it permits a wire for retractor or labial arch to be passed out between the second premolar and molar, and the making use of the premolar as well as the molar assists in retention of the front end of the plate.

Fig. 3.—An upper removable appliance, with clasps on the deciduous molars and permanent incisors.

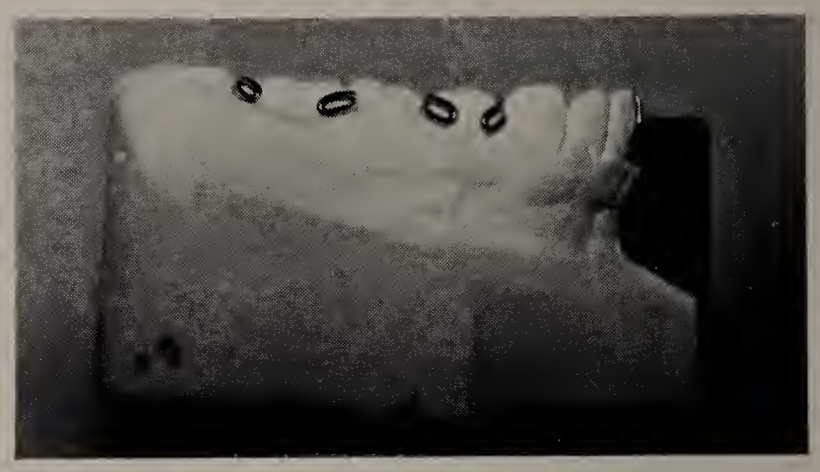

Fig. 4.—Shows the clasps on a lower model.

Fig. 5.—Shows the clasp arrangement for an upper removable appliance to retract the canine.

Fig. 6.—A fixed appliance to close $\underline{1|1}$ together.

NYLON ELASTIC LIGATURES

Two and a half years' experience with the use of a nylon elastic ligature material in conjunction with fixed appliance techniques encourages the author to recommend the material to colleagues. Manufactured by the Rocky Mountain Metal Company of America, it is composed of a rubber core within a nylon sheath. It is supplied in three weights—light, medium, and heavy. The author's experience has been with the use of the light and medium weights, and it is doubtful if the heavy weight

could be applied, except for use with extra-oral headcaps. The material wears well, and does not quickly become foul. The tension induced is well maintained, rapid and symptomless tooth movement being achieved.

Fig. 6 shows the material used for closing incisors together. Ordinary ripple brackets are used on the bands, and a length of 0·5-mm. wire bent back on itself is passed through the brackets, the free ends being bent inwards. A length of the lightweight elastic is passed round the projecting ends of the wire section and drawn together with a fair amount of tension. The knot should be made first with a double tie, to maintain the tension whilst the second tie is completed.

Fig. 7 illustrates diagrammatically some other tooth movements which have been achieved with the use of the material.

A. In multi-band techniques coil spring sections can often be dispensed with. Instead, a short length of the elastic is tied under tension between the anchorage teeth and the tooth which is to be moved. Tooth movement will be effected within two to three weeks, and a fresh piece of elastic is tied if further movement is desired. The lightweight material is used for these small movements.

B. For rotations, especially of premolars, the elastic may be tied directly round the buccal archwire, or to a stop made at a strategic point in the archwire.

C. A similar procedure is adopted to bring teeth into the arch, as after surgical exposure.

The medium weight material is used for intra-maxillary traction. With practice the material is easy to handle, and the degree of tension required soon estimated.

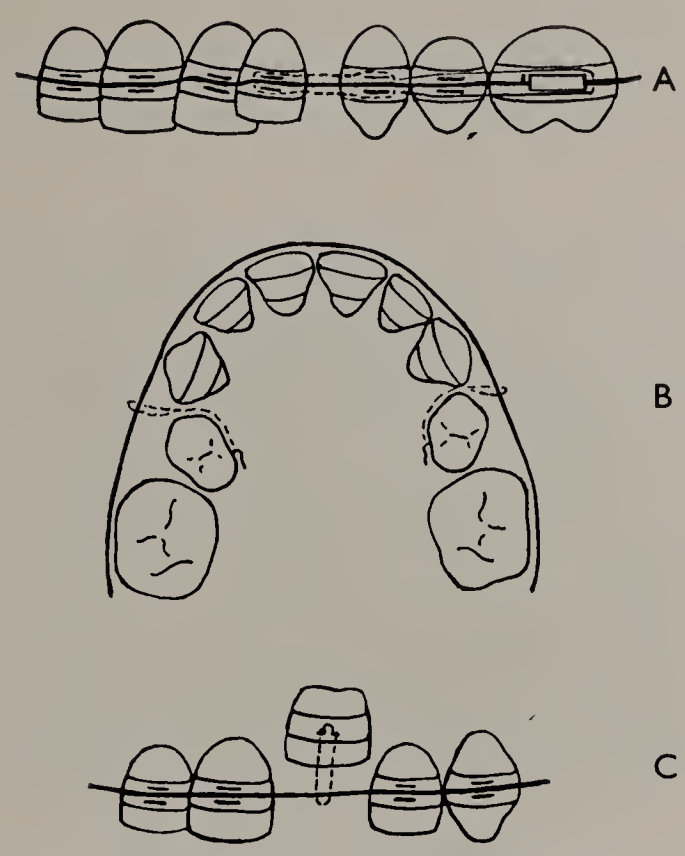

Fig. 7.—Illustrates diagrammatically the use of nylon elastic in fixed appliance techniques. A, $\underline{|3}$ has been retracted and is tied back to $\underline{|56}$ with wire. Nylon elastic is being used again to move $\underline{|2}$ back to $\underline{|3}$; B, shows rotation of $\underline{5|5}$; C, Moving $\underline{|1}$ occlusally after surgical exposure.

Acknowledgements.—I am most grateful to Mr. H. Hayden Hunt, of Bournemouth, for the photographs, and also to Bournemouth Orthodontic Attachments Ltd., Bournemouth, for the demonstration models.

SOME METHODS OF ROTATING TEETH

By **D. G. HUGGINS**, B.D.S., F.D.S., D.Orth. R.C.S.

Senior Registrar, Liverpool Dental Hospital

THERE are many problems which have to be faced during orthodontic treatment, and rotation of teeth can be acknowledged as one of them.

Many appliances have been designed to overcome these difficulties, and the following selection has been found to be useful in day-to-day practice. In no way is it claimed that the designs of these appliances are original, but it is hoped that presentation of them as a group with similar aims will be of some interest to colleagues.

A demonstration given at the Bournemouth meeting held on May 6, 1961.

REASON FOR ROTATION

1. Prior to mesial or distal movement to allow free movement in cusps and fossæ.

2. To provide space in the arch, as in the case of lower premolars which have rotated due to loss of lower first molar (prematurely).

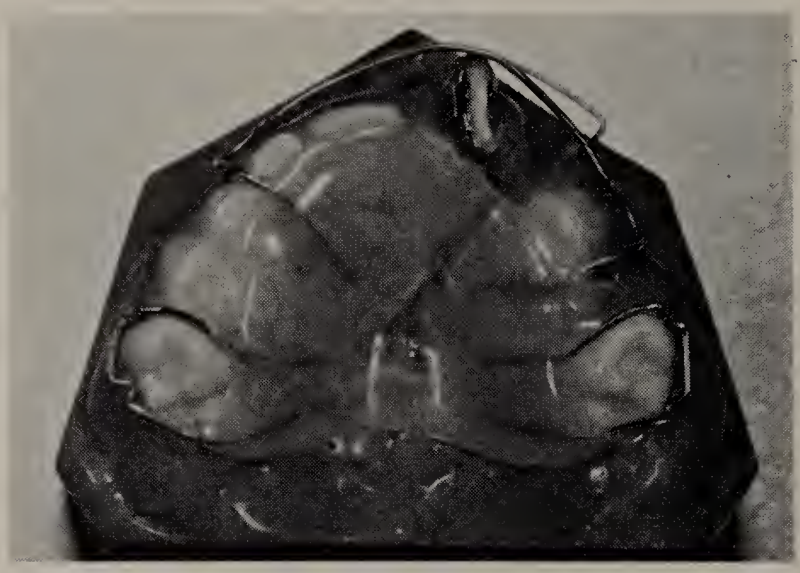

Fig. 1.—Occlusal view showing auxiliary spring engaging labial bow.

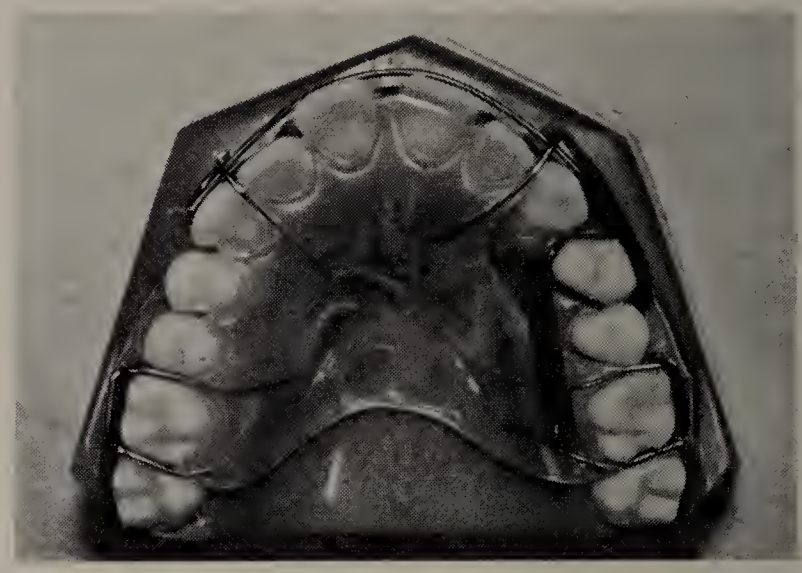

Fig. 2.—$\underline{|4}$ to be rotated by rubber bands, occlusal view of appliance.

Fig. 3.—Rotation of $\underline{|2}$, incorporation of a coil, increases the resilience of the arch.

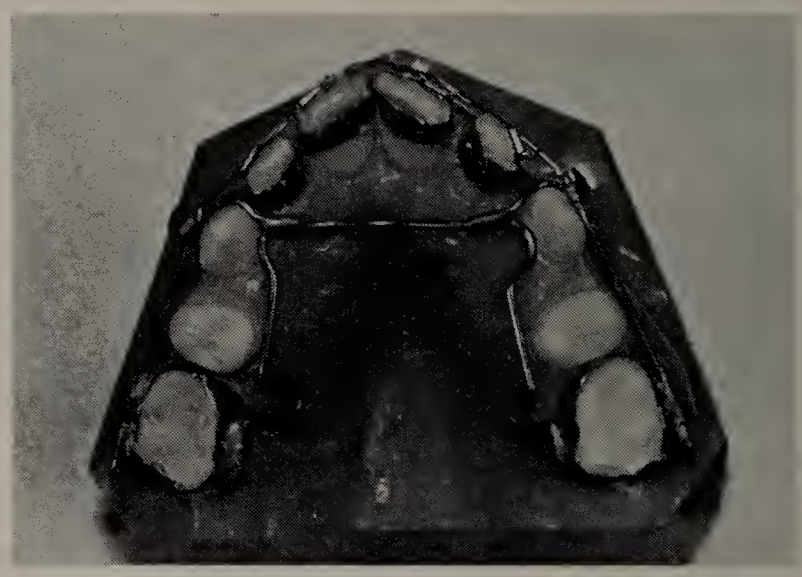

Fig. 4.—Occlusal view showing additions placed mesially.

3. Prior to labial movement or retraction of incisors.

4. Over-rotation is required to allow for slight relapse, and retention for nine months is the accepted procedure.

5. To improve the function and æsthetics of the dentition.

In the appliances discussed the teeth to be rotated are banded so that a definite point for application of force can be obtained.

Rotation of an upper incisor can be accomplished using an upper removable appliance in conjunction with an auxiliary spring in the removable appliance. Being detachable, the auxiliary can easily be replaced as necessary.

Premolar rotation is shown using a fixed-removable appliance (*Fig.* 2). The upper removable appliance is used to provide anchorage, whilst the band on $\underline{|4}$ to which palatal and buccal hooks are soldered (double 0·5-mm. soft stainless-steel wire) give definite points from which traction can be applied with rubber bands. A mechanical couple is set up by which over-rotation of the tooth can be obtained.

A modification of the pin-and-tube appliance (Watkin, Watkin, Clifford, and Murray, 1958) is shown for rotation of |2 (*Fig.* 3). The |2 4 6 are banded, 2|3 having been previously extracted. The round arch of 0·018 high-tensile wire can be activated to rotate and later retract as it is adapted to fit the square

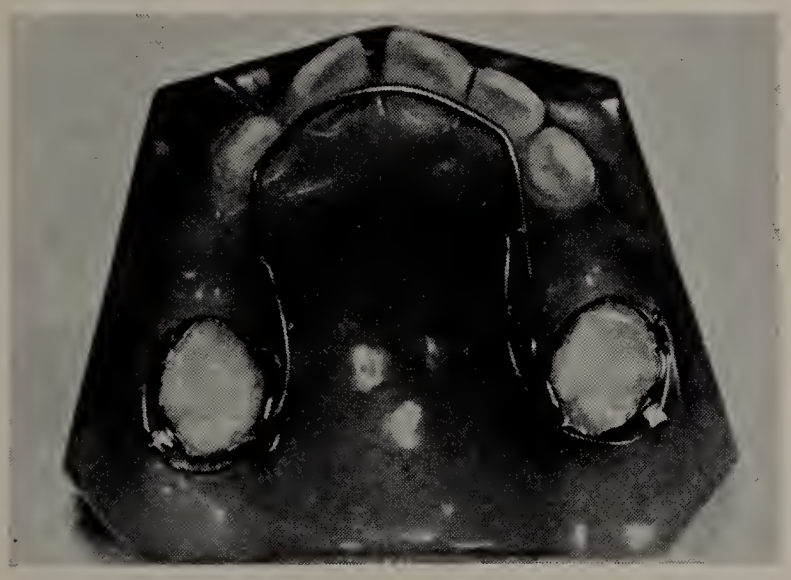

Fig. 5.—Friel rotator with auxiliary springs engaging the main arch.

section McKeag box. Ligaturing the sectional arch to the ripple bracket on |4 avoids arch distortion.

A twin-wire arch appliance (*Fig.* 4) can be utilized for rotation of incisor teeth (Mills, 1959). As a degree of over-rotation cannot be obtained by tying in the twin arch to the brackets even when offset, additions to the bands are made using 2·5 × 0·25-mm. soft stainless steel tape. The fulcrum for rotation is therefore moved labially from the tooth surface. Two methods of attaching the tape are shown. Grooves are either cut or moulded into the tape where the arch impinges to ensure that it does not slip from the fulcrum.

A Friel rotator (Smyth, 1930) is shown in a case where upper molar teeth had rotated forward (*Fig.* 5). The tooth movements required were proclination of 21|12 and a distal rotary movement of 6|6.

The bands on 6|6 allow 0·35-mm. auxiliary springs to be attached, so rotating them around the pivot provided by a 1-mm. palatal arch seated in vertical Selmer-Olsen tubes. As the palatal arch impinges on the anterior teeth, the slight forward reaction occurring during rotation of 6|6 will procline the upper incisors.

Rotation of teeth using a multiband type of appliance can be carried out using: (1) Third power bend (Hill, 1954); (2) A modified Strang rotator (Strang, 1943); (3) Auxiliary arms from ripple brackets to arch.

Fig. 6.—Showing distortion produced by "tying in" third power bend.

1. It is common to find lower canine teeth rotated, and prior to retraction or closing residual space in the arch it is usual to aline them. This can be carried out by using third power bends in an 0·016-in. high-tensile arch (*Fig.* 6). These bends give added length to the arch, increasing resilience where it is required. If a plain arch is tied in it may be permanently deformed and produce no rotary movement. The third power bends shown are partially tied to offset brackets, and on future visits more complete engagement of the arch in the bracket would produce over-rotation of the teeth concerned. Similarly, centrally placed brackets and eyelets may be used.

2. Rotation of the molar and incisor teeth may be brought about by the use of the modified Strang rotator (*Fig.* 7) (Strang, 1943). The premolar to be rotated has drifted as a consequence of early loss of the first permanent lower molar. The object is to move the distal aspect buccally, and to do this an auxiliary of 0·016-in. high-tensile wire is attached to the buccal surface of the band. The auxiliary

is formed as shown (*Fig.* 8) and inserted into a tape tube on the disto-buccal area of the band (*Fig.* 9). When the main arch is tied in, the loop on the auxiliary is tied to the arch to prevent unwarranted movement of the tooth.

Fig. 7.—Showing the relation of the auxiliary to the main arch.

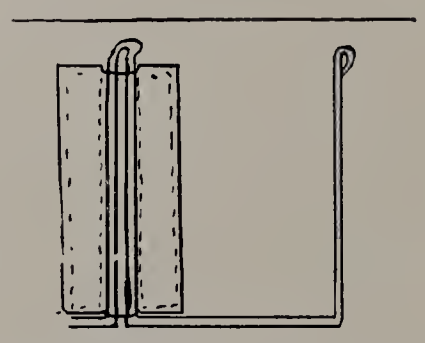

Fig. 9.—The "D" section formed in stainless steel tape is welded to the band to form a tube into which the auxiliary spring can be inserted.

The auxiliary being activated buccally, but its movement being prevented by the main arch, the distal aspect of the tooth is moved buccally and the mesial lingually. A disadvantage of this method is the frailty of construction.

3. This method of rotating teeth is a variation of that mentioned previously, where an auxiliary beam-type spring from a banded tooth was attached to a removable appliance. Here the beam spring engages the main arch of a multiband appliance and in *Fig.* 10 rotation of $\overline{5|5}$ is in progress.

The auxiliary spring of 0·016-in. high-tensile wire is threaded through the ripple channel on $\overline{5|5}$ bands, and a hook at its free end engages the main arch. This method is useful for gross rotations where the deformation of a third power bend would be excessive. Over-rotation can be obtained by bending a step in the auxiliary arm.

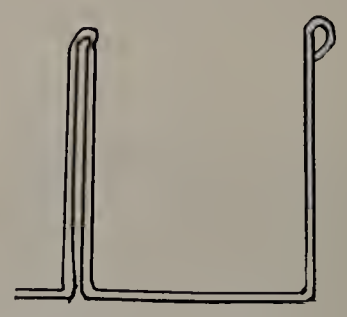

Fig. 8.—Illustrates the form to which the high-tensile wire is adapted.

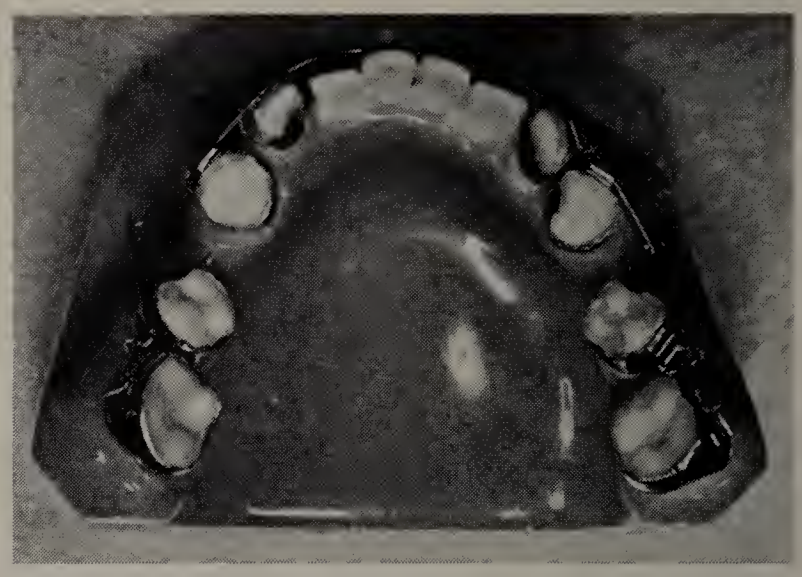

Fig. 10.—The auxiliary spring to $\overline{|5}$ is passive, whilst the spring to $\overline{5|}$ engages the main arch.

The fact that there are numerous methods available for carrying out one basic type of tooth movement suggests that each tooth requiring rotation must be assessed on its merits, and no one mechanical method should be used to the exclusion of all others. No doubt this series is incomplete, but it can only be hoped that others will be encouraged to add to the above as they think fit.

Acknowledgements.—The writer would like to express his appreciation of help given by the staff of the Eastman Dental Hospital and the Dental School, Liverpool University.

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AN APPARENTLY STRAIGHTFORWARD CASE

By **J. S. ROSE**, B.D.S., F.D.S., D.Orth. R.C.S.
Senior Lecturer, London Hospital Dental School

CASE REPORT

In August, 1952, Hazel, aged 6 years 1 month, presented complaining of protruding teeth.

On examination she was seen to be an Angle Class I case with A|A very loose and protrusive. The 1|1 were erupting palatally to the retained deciduous teeth. In September, 1952, A|A were extracted. By November |1 had erupted into normal occlusion, but 1| was lingual to the lower arch (*Fig.* 1). The patient was instructed in the use of a spatula on the misplaced tooth, and asked to return in one month. Owing to illness she was not seen again till May, 1953, when 1| was still inside the bite. Because of apparent crowding $\frac{CB|BC}{C\ |\ C}$ were extracted. In August, 1953, an appliance was fitted to move 1| into the arch. This was discarded in December, with the incisors in good alinement. At this time, however, a clinical note was made to the effect that the case might be developing into an Angle Class II malocclusion.

Hazel was then kept under observation till February, 1955, when further records were taken (*Fig.* 2). At this time she had a frank overjet and her first permanent molars suggested an Angle Class II relationship. It was therefore decided to begin some intermaxillary traction. In July, 1955, a monobloc was fitted. This was finally left out in February, 1958. The models taken in June, 1959 (*Fig.* 3), show a reasonable incisal relationship and a good buccal segment occlusion on the left-hand side. On

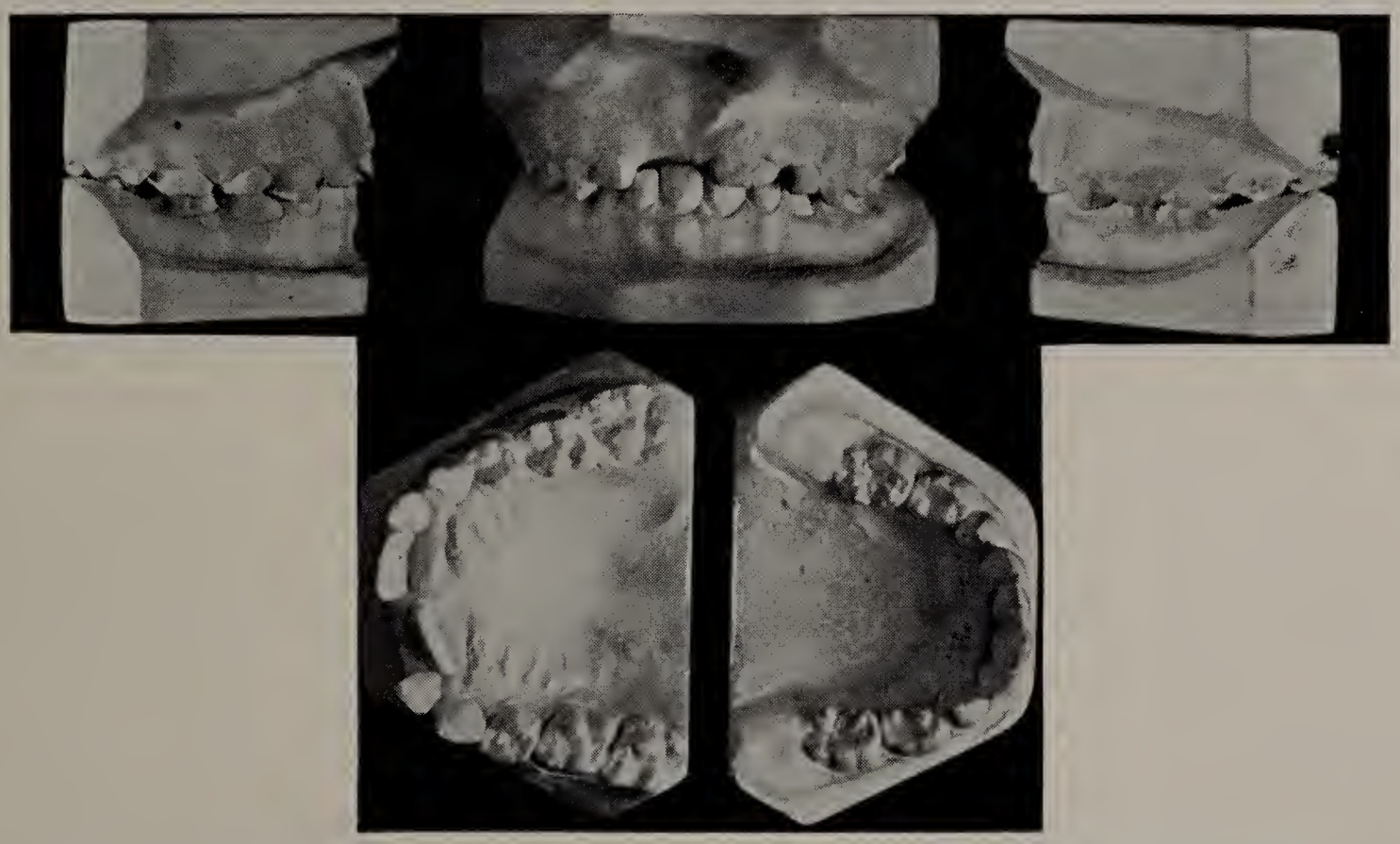

Fig. 1.—Before treatment. Note normal overjet and normal buccal segment relationship.

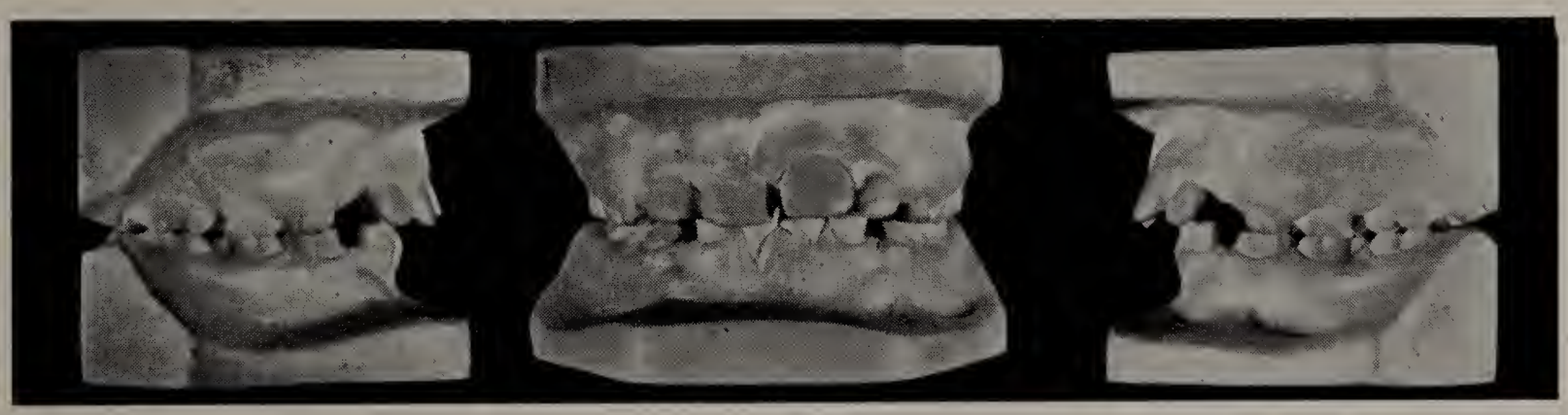

Fig. 2.—After correction of 1| and extraction of $\frac{CB|BC}{C\ |\ C}$. Note increased overjet and tendency to Angle II relationship of buccal segments.

Given at the meeting held on October 9, 1961.

the right-hand side the relationship is not so good, because $\underline{5|}$ is rotated through a right angle. When the patient was finally discharged 17 months later the occlusion was unchanged.

The interest of this case lies in the change from a Class I to a Class II occlusion. This might have been anticipated if it had been realized sufficiently early that the presenting occlusion was a postural one. Once $\underline{1|}$ had been moved into alinement, the mandible could follow its normal path of closure into a Class II position. This allowed the lower lips to insinuate between the upper and lower incisors and exaggerate the incisal discrepancy. It is interesting to speculate as to whether the overjet would have been so marked if $\overline{C|C}$ had not been extracted.

Since realizing the problem described above, I have seen several similar cases, including an apparent postural Class III which turned into an Angle Class II, division 2.

Fig. 3.—Models after treatment with a monobloc which had been discarded 16 months previously.

Perhaps this case might serve as a reminder that all simple cases might not be as straightforward as they seem.

Acknowledgements.—My thanks are due to Mr. H. E. Wilson for permission to publish this case and to the Photographic Department of the London Hospital for preparation of the slides and prints.

DISCUSSION

The Chairman thanked Mr. Rose for presenting precisely the type of short communication of which a great many were needed, going right through the whole of the history and treatment of the case up to the eruption of the second molars.

Questions on the communication were invited.

Mr. J. S. Beresford said he would like to ask Mr. Rose when cases of postural Class I to Class II were discovered, when were they treated, or did one treat them at all?

The Chairman said it would be interesting to see any tracings of the change which had taken place as a result of the child wearing the corrective device. Also, could Mr. Rose say whether he would again extract a deciduous canine under similar circumstances?

Mr. Rose said he had been asked a question which he would have preferred not to answer because he did not really know the answer. By and large, however, he would have waited in such a case, unless the lower incisors were being traumatized by the upper ones, and the lower gingivæ being stripped by opposing teeth. Apart from those factors he would leave it. One thing he would not do, if treating the case again—that was, extract the lower deciduous canines.

He regretted that he had no tracings of that particular case.

THE TOOTH, THE BONE, AND THE MUSCLE

By **DESMOND GREER WALKER**, M.D., F.D.S. R.C.S.

THERE should be no artificial limitations on the pursuit of knowledge. From that it follows that no speciality should allow itself to become too narrow, restricted, and self-contained. Dentistry is subdivided into innumerable sections, and it is pertinent to inquire if some of the divisions are too narrow. If we apply this argument to orthodontia, can we justify such a limited field which concerns itself with the regulation of the teeth? Should the orthodontist extend farther into the field of prevcntive dentistry? Should he be responsible for the child's complete treatment and thereby become the dental pædiatrician? Should he undertake certain surgical procedures? These questions naturally are the concern of the specialty, and it would be very wrong of me to offer any suggestions. Perhaps, however, I could with some justification put forward the view that the subject might be broadened to include malformations of the face and thereby cover the whole spectrum of variations. The orthodontist's study is basically morphology and physiology and no limits ought to be set; all forms and functions ought to be analysed. Therefore when I suggest the expansion of your specialty to include teratology, I hope that what I have got to say will influence some of you to enter this closely related field of facial malformations.

The integration of differing growing parts is still one of the greater mysteries. Various hypotheses have been put forward about the growth mechanism and there is nothing gained by reiterating the various viewpoints. An aspect not often chosen for the elucidation of what grows and how it grows is the study of defective parts and the consequent result, but by such studies defects of the teeth, the bone, and the muscles can be analysed and their influence assessed.

At the outset it is well to remember that certain general laws or principles are applicable throughout the body. Before any special case is made for the facial structures it is best to make sure that there is sound reason for a departure from the general behaviour. Possibly the specialized study of the teeth has precluded the individual from studying the digits; and in a similar manner the individual who is interested in the migration of the teeth has had no inclination to observe the process of binocular vision or the descent of the scapula.

In many ways there is a remarkable similarity between the digit and the tooth. The long and interesting history of the phylogenetic reduction of the tooth series bears a very close resemblance to that of the digits. Perhaps the instance to-day of the further evolutionary trends in the dental complement as exemplified by the missing lateral incisor is not paralleled at present in the digital structures, but the phylogeny of hand and mouth bears striking evidence of common happenings. Apart from the numerical variations, the part itself needs adaptation and specialization. Once more, the tooth, in its many forms, and the hand, with syndactylous and other variations, demonstrate many changes. The part itself needs a universality for the various creatures, and no better example can be chosen than the process of binocular vision. According to the particular animal the eyes must be placed in a certain situation varying from the lateral to the anterior aspects of the face. It is not always appreciated that these developmental processes can be halted; in other words, when the eyes start to move from the lateral aspect of the head to occupy their position anteriorly in the human face the process can be stopped with the resulting malformation called hypertelorism. In a similar manner there is the developmental descent of the scapula from the neck to the thorax. If this descent is prevented the clinical condition of Sprengel's shoulder or high scapula is produced.

The movement of the teeth in the jaws is far from fully understood. Reference is often made to delayed eruption, submerged teeth, over

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eruption, and failure to erupt, but not many view this special dental mechanism as a matter for study in a manner comparable to that of the disruptions that occur in the migration of the orbit and the scapula. It is known that the eruptive process can be interfered with in the condition described as cleidocranial dysostosis. The need for further work in the field of tooth movement is illustrated in the following case. A child with unilateral condylar growth failure was treated along the usual lines of elongating the jaw by an interstitial bone graft. The ramus of the jaw was divided in the region of the unerupted second molar just proximal to the developing third molar germ. In the course of time the third molar developed and migrated through the bone graft to erupt into the mouth. The condylar agenesis was the result of an infection in early childhood, and when the length was restored the normal migratory mechanism was restored. A similar state of affairs takes place in the dentigerous cyst and if the cavity is simply opened to the surface of the mouth the unerupted tooth will erupt.

The close bite in some of the more minor variations may yet be explained along the lines of anomalies in eruptionary potentials. In the meanwhile, it is as well to remember that the scapula, the orbits, and the teeth all migrate.

To proceed with the original premise that in general the parts are subjected to common laws, the study of the behaviour of the tooth and the bone is very interesting. One of the great advances in orthodontia, if not the greatest, was to demonstrate that teeth could not be pushed anywhere by mechanical devices and be expected to remain stable. Until some twenty years ago the maxillary arch was subjected to countless expansion plates and in most instances to no avail. The axial inclination of the teeth, all that was achieved, dispelled the old belief that expansion actually took place in the palate. The teeth that were so inclined buccally returned to their upright position when all forms of retention were stopped. But once more there appears to be a general law, and whether attempts are made to alter certain tooth arrangements or bone shapes the same problem is evident. The shape of bone is just as carefully maintained as the forms of the dental arches. Admittedly there are certain things that can be done, such as elongating bone surgically or extracting upper premolars and retracting the incisors, but certain other operations or orthodontic procedures, as you will know, are doomed to failure.

It is surprising how a bone or the dental arch will strive to grow into its predetermined shape and any attempts at alteration will bring into play a compensatory mechanism for the re-establishment of the original form. It cannot be laid down that changes can never be brought about—so many factors are involved that it is difficult to define clearly what can and what cannot be achieved. In one respect a most interesting example of the process of recovery is the Pierre Robin syndrome, a form of congenital micrognathism. A body of opinion maintains that the causation of the micrognathism is the persistent cephalic flexion in utero whereby the jaw is compressed against the sternum. When the child is born there are the consequent obstruction difficulties, but if it can survive the first three months it will develop into a normal child. The compressed jaw reverts to its original shape. Is this not a similar state of affairs to the upper dental arch which collapses after the expansion plate is removed?

There is the temptation to inquire whether there might be some mechanism common to the bone and the tooth for the preservation of form. There can be little doubt that the periosteum which covers the bone is an important agent in maintaining the external shape. The fracture that unites in a displaced position is remoulded and any projecting parts are smoothed out in a comparatively short time. I have, on a previous occasion, allotted a similar role to the periodontal membrane when relapses occur after orthodontic treatment. To a large extent no definite conclusions can be drawn, but as a maintainer of tooth position in the dental arch, whether it be anterior or posterior teeth, those proclinated or rotated, that theory does offer a certain universality. The teeth are often referred to as

lying in a sea of muscle influence and undoubtedly the neuromusculature must be considered, but in cases of strongly genetically determincd arrangements one cannot help attributing to the periodontal membrane some function other than just a sling for the tooth.

So much has been said about the inherent genetic factors that it is timely to point out that any growth is a striving of the part to produce what is predetermined, but it may not arrive at its destination owing to adverse influences. There are many disruptions by way of one disease or another preventing the ultimate form. An excellent example showing the disruption of the normal growth process is scoliosis of the spine, and what occurs in the spine is evident in the face with the vast array of facial asymmetries. Just as the powcrs of determination are great so are the evils that can delay eruption, prevent binocular vision, and distort the face.

It is only in comparatively recent years that the influence of the soft tissues on the growth of the face has been studied. Following the change of emphasis from the bone to the muscle many bitter arguments have arisen and this is undoubtedly due to the difficulty of proving any hypothesis about facial growth. Taken in large, therc can be primary defects in the skeletal structures, in thc teeth and their mechanisms of formation and movement, and finally in the neuromusculature. Any one of these elements can fail and variate and the difficulty lies always in deciding what is likely to be the primary error. Who is competent to adjudicate on the open bite with the certainty of being able to distinguish between what may be a primary skeletal error or the results of a misused tongue? The problem appears a little easier in the more gross anomalies, and in an attempt to shed a little light on the complex issue certain malformations of the neuromusculature will be examined.

Since it is suggestcd in certain quarters that the lips are active agents in some cases and responsible for certain tooth irregularities, it should be instructive to examine the effects when, either through a muscle or a nerve lesion, the lips are inactive. Such cases are the familiar congenital facial palsies where it is said that the lesion is in the nucleus. Assessment of these cases which can be bilateral or unilateral in character has shown no ill-effects on the dental arch. Quite distinct from the nerve lesions the muscle can be affected in such cases as are commonly described as "first arch lesions". Frequently in these cases there is also defective fifth musculature and in common with the previous nerve lesions no dramatic changes in the dental articulation are noted.

In complete contrast, the tongue seems to be a potent factor and many instances could be enumeratcd to support this point of view. One of the most striking cases was a lymphangioma of the tongue which produced a marked separation of the anterior teeth. Following partial resection of the tongue and a small amount of orthodontic treatment the normal incisor relationship was restored.

On the evidence of abnormalities in the facial neuromusculature it seems that a minimal influcnce is exerted by the lips, whereas strong evidence supports the hypothesis that the tongue can produce changes in the occlusion. It would undoubtedly be erroneous reasoning to say that the above experiments in nature are final and conclusive. The information may tend to strengthen a certain line of thought, but it is not sufficient for generalization. It is rather interesting how frequently malformations of the skeletal tissues are described and accepted, but the very thought of abnormal physiology as opposed to abnormal anatomy raises some doubts.

It is a pity that thc study of the musculature of the face has once again offered another instance of limitation and that the orthodontist has not undertaken the broader approach to reconcile the apparent differences between the minor variations and the major anomalies. Abnormal physiology, a study in the widest context, must attempt correlation of the whole spectrum. Satisfactory explanations must be put forward to explain why the behaviour pattern should vary from the pathological lesion. On the evidence so far found it would seem that less emphasis ought to be placed

upon the lips and more upon the tongue. If a dichotomy leads to a set of rules for each study we shall depart further from a clear understanding of the influence of function.

It will be appreciated that in orthodontia there are two slightly opposed factions—the physiological and the morphological—the one attributing more importance to the role of the orofacial muscles and the other to the bony structures and their inherent qualities. Form and function cannot be separated so easily, and a combined understanding of these two complementary factors is essential, and in the widest possible manner.

DISCUSSION

Professor D. P. Walther, opening the discussion, said it must bc obvious to everyone present, both from listening to this paper and after having read his excellent book on *Malformations of the Face*, what an enormous amount of time and hard work Dr. Grecr Walker had put into what could only be described as his "hobby".

There was no question that an analysis of a large number of cases with gross malformations was of vital importance to orthodontists. It was from the rather gross alteration in thc growth pattern that they might find some clue through the secondary changes which took place.

He wished to ask Dr. Greer Walker whether he was contemplating starting a serial study of these cases, using cephalometric X-rays, study models, and detailed clinical assessment which could be compared with a control group from a normal cross-section. He would probably have the answer to many of their problems if he did so, and the analysis should prove fascinating. He believed that the prognosis of a case must depend very largely on the individual's inherited skeletal pattern and soft-tissue behaviour upon which the deformity had been superimposed. That would certainly appear to be the case with the cleft-palate children, and it was very difficult to assess.

The author's paper was so full of interest that he was greatly looking forward to seeing it in print and fully digesting it. He only wished he could have had a preview of it enabling him to marshal his thoughts better. Instead, he had read the author's book and found it most stimulating.

He himself agreed that it was very difficult and dangerous to use the term "normal", but suggested it would be very useful to obtain an average around which to work. He had been most interested in the author's discussion of the relative importance of the size and activity of the tongue, as against the morphology and behaviour of the lips, in the aetiology of malocclusion. He himself found it difficult to be dogmatic and to generalize. Each case, he thought, had to be assessed on its merits individually; and it was the balance of all the forces that was important.

Mr. P. H. Burke said Dr. Greer Walker had shown patients in whom the condylar growth centre had been "knocked out" unilaterally by infection or radiation. Taking it a step further, the orthodontist might be involved with regard to treatment of the paticnt and as far as could be seen the alternatives were either to accept the distorted base relationship produced by the growth abnormality and treat patients by masking operations combined with orthodontic treatment, or to solicit the aid of the surgeon to reposition the dental bases by bone-grafts which might have to be serial. Could Dr. Greer Walker, from his wider experience, say which was the most successful line of treatment of patients with this type of facial malformation? After bone-grafting-could one expect a response in vertical growth of the maxilla on the corresponding side?

Dr. Greer Walker had shown a slide of a patient who had a bone-graft through which the third molar eruptcd and it had been called a mystery; but this assumed that the primary tissue responsible for tooth eruption was bone. If the primary tissues were included in the pulp of the tooth, and bone was used as a scaffolding—that is, as a secondary tissue—there was no longer any mystery.

Mr. J. H. Hovell said Dr. Greer Walker had put forward a plea for a broadening of their vision. They had to consider orthodontists in two classes. There was the practical orthodontist who, while he was treating large numbcrs of patients, was not in a position to go deeply into the subject; and there was the research worker, working in places like institutions or hospitals, for whom that was a most important paper.

In discussing the Pierre Robin syndrome he had put forward in his book a convincing case which, on this occasion, he had been unable to substantiate because of lack of time. The paper to which they had listened was of great importance to orthodontists in assessing the unusual case in which one had to decide where the fault lay—whether it was bone or muscle and whether it was a case for the oral surgeon, and the surgical procedure to be adopted. As orthodontists they sometimes had to advise oral surgeons and recommend a course of procedure; and they had to be able to say whether, for example, a bone-graft was likely to succeed or fail in relation to a mandible. If they knew what the basic anomaly was and where the fault lay, if a bone-graft would be likely to resorb or to succeed and encourage maxillary growth which would be altered by the deformity, the whole procedure became much easier.

In a presidential address delivered to the Royal Society of Medicine some years ago it was said that the lips were considered to be like curtains hanging round the teeth without playing any active part in the positioning of the teeth. At that time he had been horrified, but he was now coming more and more to acceptance of the view that this was so.

He wondered why the author should consider "first arch dysplasia" an incorrect term. Aetiologically, there might be various reasons, but in fact anatomical malformations of structures arising from the first arch werc present. Did not this term describe the syndrome?

Dr. Greer Walker said he wished to thank Professor Walther for his very kind remarks. They had worked together on the subject.

With regard to comparison with the variations around the norm, that was of course badly needed. They were up against lack of time to do work of that kind. He believed there was a great deal to be done on those comparisons, but he was taking the reconstruction as the first stage, and they would go on from there.

The problem of ankylosis was one which became easier when one saw a large number of cases in relation to whether there was a severe disturbance of condylar growth or only a slight one. He believed they would not bother about the slight ones, but the severe cases must be dealt with in accordance with the deformity present.

As surgery advanced and those procedures became more simple, making it possible to elongate without any noticeable asymmetry, they would do so; but cases which were likely to end with a deformed face ought to be corrected surgically.

With regard to the maxilla growing down, the trouble occurred in keeping the mandible down and creating space. He himself had never resolved that problem in his own mind because he had found that if one opened the bite on the one side, then the other side was affected and a difficult mechanical problem arose.

He was interested in Mr. Hovell's comments about the tongue. When there was a thrust-out tongue with a tumour, they chopped off the tongue and got normal dentition.

Mr. Hovell had spoken of the first arch. He personally felt that it was an over-simplification to plunge all these abnormalities together as "first arch abnormalities"; the aetiology varied. However, "a rose by any other name would smell as sweet".

The Chairman thanked the author for his paper and also all those who had taken part in what had been a most interesting discussion.

ORTHODONTIC THEORY TO-DAY

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It is probable that the advice of Celsus* (25 B.C.) to aline a misplaced tooth by daily pressure with the finger was the first doctrine of orthodontic treatment. It is also interesting to reflect that this advice, with the addition of some refinements as regards the means of applying pressure, has remained fundamental to orthodontic practice ever since.

While Celsus, however, pointed out the need to recognize misplacement of teeth and enjoined the advisability of repositioning them correctly, the modern orthodontist, while following this advice in the first instance, began also to wonder why it came about that teeth were misplaced, and sought to explain the occurrence of irregularity. This curiosity and spirit of inquiry led, in due course, to the suggestion of explanations as to the causation of irregularity on the basis of clinical experience, and suggestions arising in this way were originally the subjects on which discussion and argument took place.

It cannot be said that agreement has yet been reached on any really wide field of orthodontic doctrine, so that there seems to be room for some assessment of present-day orthodontic theory, with special reference to the way in which it has evolved and the way in which developments might be encouraged in the future.

TWO ASPECTS OF MALOCCLUSION

Those who at first were mainly interested in problems of irregularity and malocclusion were, naturally enough, dental practitioners, as they were daily faced with the problems arising from irregularity and found it necessary to do something about them. Others, too, not primarily concerned with the clinical problem, came across dental irregularity in the course of the study of graveyard and fossil material, finding in the form of the cranium and face and in the arrangement of the teeth clues in the scientific inquiry into the evolution of man.

It is clear, of course, that the two viewpoints suggested—the scientific and the clinical—have different objects to achieve in the first instance. The scientist seeks to discover the truth about the nature of developmental and evolutionary changes or about other biological processes, and possibly about the nature of irregularities without, in the first instance, specific reference to whether the facts he finds are useful or necessary. He may also spend as long as he thinks fit on reaching his conclusions. The clinician must find answers to his clinical problems because they are necessary; the answers he finds must be useful and must usually be found within a specified time.

Orthodontic theory as elaborated by orthodontists has, from time to time, been criticized by those engaged in related biological studies as lacking scientific foundation. It is therefore proposed to discuss the nature of orthodontic concepts as elaborated in the clinic and the connexion between the clinical approach to orthodontic problems and the more formal scientific subjects related to it.

CLINICAL ORTHODONTIC THEORY

Early orthodontic practice was based on the principles of Celsus with assistance derived from dental prosthetics, which offered the possibility of applying pressures to the teeth more accurately and more continuously than could be done with the fingers.

In time there began to appear inquiries regarding the nature of irregularity and malocclusion, and it is striking to note how invariably the theoretical background developed by the orthodontist is tied to his

* "In children too if a second tooth is growing up before the first one has fallen out, the tooth which ought to come out must be freed all round and extracted; the tooth which has grown up in the place of the former one is to be pressed upwards with a finger every day until it has reached its proper height."

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clinical problems. This aspect of the matter may be illustrated by consideration of some orthodontic doctrines of the past and some aspects of current developments in orthodontic ideas as formulated by clinicians.

E. H. ANGLE

The most outstanding instance of the formulation of orthodontic doctrine is, of course, to be found in the teaching of E. H. Angle (1907). Rather than add fuel to the fires of controversy that this doctrine lit many years ago, it is more salutary to see the development of the Angle concept in its context, and to appreciate it as an advance in the development of ideas in its time.

Before the time of Angle, orthodontic methods of treatment were mechanically crude and unsystematic in theory. Many of the descriptions and classifications of malocclusion were limited to the teeth in the labial segments, and the practice of orthodontics was a facet of the practices of restorative dentistry and of the surgery of the jaws and teeth. Angle crystallized the conception of the occlusion of the teeth as the unit, not the tooth, and stressed the need for concentration on the study of facial form and relationships and the effort to achieve correct occlusion as far as possible. Angle insisted on the necessity of separating such studies from the accepted study of dentistry at that time; dentistry of the tooth and of tooth pathology as opposed to the study of the phenomenon which is the occlusion.

To-day the orthodontist, born and bred in the tradition of the Angle classification of malocclusion and accepting it as second nature, finds it easy to miss the significance of the impact of Angle's conceptions on the orthodontic and the dental scene and fails to realize the stimulus that was given to orthodontic thought some sixty years ago. The insistence by Angle on the study of the occlusion, and in particular the perfect occlusion, and of the form of the face in its finest proportions was probably the first formal, basic lesson the orthodontist had ever been given.

There is no need now to repeat at length the verdict of time on the Angle doctrine, but what does sometimes arise is the question of how such a doctrinal attitude came to be so widely accepted! On reflection, it is not really so strange.

In the first place, the growing specialty of orthodontics was developing outside the sphere of formal teaching and was unorganized in the extreme. The appearance of a single-minded enthusiast prepared to devote every particle of his energy to dealing with orthodontic problems in all their aspects could not fail to attract the attention, and indeed the devotion, of those who felt the need for organization, information, and guidance. And is it not as true to-day that such is the nature of orthodontic problems that whenever there appears a theory which embraces all aspects of the subject, it finds a welcome, and, indeed, ready acceptance as a basis for the clinical approach to orthodontic problems?

Generalizations of different kinds regarding the nature and causation of irregularity and malocclusion have come and gone, each indicative of attitudes and attempts to produce rational ways of deciding how to treat clinical orthodontic problems. A few of these will be mentioned in further illustration of this point.

ADENOIDS AND MOUTH-BREATHING

The idea that narrowness of the upper dental arch could be due to constriction or blockage of the nasal passages is of ancient origin, and much time and effort have been spent in treating such cases, either by the removal of the blockage, if caused by adenoid tissue, and thereby hoping to promote development of the dental arch, or by widening the dental arch and aiming thereby to promote a corresponding widening of the nasal passages.

By the time Brash (1956) wrote his treatise on the *Aetiology of Irregularity and Malocclusion of the Teeth*, the controversy regarding the role of the tonsils and adenoids in the generation of narrow maxilla had been raging for many years. Brash was able to conclude from all the available information that there did not appear to be sufficient evidence to assume a direct causal relationship between tonsils, adenoids, and nasal obstruction, and the formation of the upper jaw and dental arch, and

that there was now, as a result of certain statistical inquiries, "a definite change of attitude towards mouth-breathing as an aetiological factor and the coincident discounting of mechanical hypotheses in general".

FUNCTIONAL ADAPTATION

The observation by Andresen that habit activities and disturbances of muscular activity could produce large and permanent anomalies in the arrangement of the teeth led him to the belief that such muscular pressures, if properly directed, could be made to produce beneficial changes in tooth arrangement and occlusal relationships. It was, in his view, "functional adaptation" that produced the striking effects in the treatment of malocclusion that are to be found with the use of the Andresen system; adaptation not only in the bone immediately surrounding the teeth, but in the main bony elements of the jaws themselves. While it is beyond doubt that in suitable cases startlingly successful results can be produced in treatment of occlusal relationship, it is also true that this system is not suitable for the treatment of certain other kinds of cases in which irregularity predominates, and the uncritical use of the system in the belief that functional adaptation will produce all the tooth movements required is bound to lead to disappointment. The limits within which function produced adaptation have not yet been sufficiently well defined to make it possible to base an orthodontic doctrine accurately on this conception; and the interpretation of the action of the functional appliance as producing pressures on individual teeth and thereby producing tooth movement in alveolar bone appears, at present, to offer a clearer line of thought on this interesting subject.

ORTHODONTIC THEORY IN CONTINENTAL EUROPE

The orthodontic doctrine of the European continent as far as it can be seen to be regional and formulated has strong undertones of pathology as we understand it in the purely medical sense.

Kantorowicz (1952), discussing orthodontic prophylaxis, says that "crowding of permanent teeth is often put down to heredity. There is nothing to indicate heredity in this case, everything to incriminate negative pressure exerted on the soft parts covering the jaws. So we have to deal either with a healthy bone which suffered pressure, or with a bone weakened by rickets unable even to resist physiological pressure."

Korkhaus (1953), in discussing orthodontic prognosis, says that "in the cases with a rachitic origin, such as high-degree compression anomalies, genuine infra-occlusion, etc., rather simple movements, for instance the opening of gaps, may prove very lengthy and be a heavy strain on the patience of the physician and subject", and in 1957, discussing disturbances of growth of the upper jaw and middle face, describes "... an orthodontic anomaly like the genuine open bite which results from an inhibition of growth due to vitamin-D deficiency".

The view of dental irregularities that sees them as the result of pathological processes or as teratological malformations seems to overlook the fact that in the overwhelming majority of patients exhibiting irregularities and malocclusions there is no history, sign, or symptom of pathological causes as generally understood.

ORTHODONTIC THEORY IN THE BRITISH ISLES

In the British Isles, orthodontists appear until quite recently to have been chary of formulating what might be called a comprehensive doctrine. The role of the tonsils and adenoids, mouth-breathing, the influence of diet and vitamin intake have all, in their time, been subjects of controversy, discussion, and investigation without the emergence of any dogma or school of thought as a basis for teaching.

During the past fifteen years there has arisen a doctrine which is widely used as a basis for teaching, and in connexion with which various lines of research have been initiated. Broadly speaking, this doctrine rests on two main foundations—first, the belief that the shape of the face, excluding the teeth

and their alveolar processes, develops in fixed proportions and independently of the dental and alveolar structures, and secondly, that the arrangement of the tooth crowns forming the dental arches and the relationship of the dental arches to one another are governed by the soft tissues of the tongue, lips, and cheeks which are the immediate physical environment of these dento-alveolar structures. Both these propositions are to-day subjects of considerable debate.

It is not intended here to oppose or defend either of these theses, but to comment on them with particular reference to the manner of their origin and the nature of the arguments about them.

Many years ago it was suggested by Brash (1924) that the proportions of the facial skeleton of the newborn infant had a strong resemblance to those of the adult. The work of Hellman (1926), using a wide cross-section of skull material from American Indian sources, reinforced this impression and added to it the idea that in the progress from infancy to adulthood the growth process made proportionate additions to the main facial outlines. The later work of Broadbent (1937), using modern living children, built up a composite picture of developmental growth establishing the idea that there is a facial pattern for the growing individual.

The formulation of the concept of the stability of the pattern of the facial bones as something that could be made practically useful seems to be based on a paper by Brodie (1941) in which serial cephalograms of 21 children between the ages of 3 months and 8 years are analysed. From this analysis the definite conclusion was that "... the morphogenetic pattern of the head is established by the third month of postnatal life... and that once attained it does not change".

The conception of the stability and unalterability of the basic facial pattern is now at the foundation of much clinical orthodontic doctrine and influences the determination of lines of treatment and prognosis of cases made from early examination and recording. The conception of the stability of facial shape is embodied in the following quotation: "(1) That each individual soon after birth has a characteristic skeletal morphology that does not change significantly throughout the growing period. (2) That no orthodontic treatment will change this skeletal morphology" (Ballard, 1957).

Since the conception of developmental growth of the face was introduced by Broadbent, several independent investigators have taken up the study of growth processes in the facial skeleton. There now seems to be good reason to believe that the shape of the face, if measured accurately, is not perfectly constant during its developmental history. Observations made by Björk (1951) between the ages of 3 years and 8 years and between 12 years and 20 years in two different cases reported show quite definite changes in facial pattern in different directions. Similar changes are suggested by Lande (1952) and Nanda (1955). Brodie (1953), reporting on a study of late growth changes in the human face, remarks in summary:—

"The mandibular border shows no appreciable change in over half the cases. In those cases when it does change, it almost invariably shows a behaviour similar to that of the occlusal plane, that is, a tendency to become more parallel with the anterior cranial base." While no appreciable change occurred in over half the cases, it seems clear that changes of some kind are taking place in the remainder, and it follows that some significance might be attachable to such changes.

It would seem, therefore, that there are strong grounds for refraining from saying, as an unqualified statement, that changes in the shape of the bony skeleton of the face do not occur.

As regards the assertion that the shape of the face or "skeletal pattern" cannot be changed by orthodontic treatment, opponents to this idea have not been lacking, their opposition being based mainly on clinical experience suggesting that stimulation or retardation of the growth of the mandible can be produced by the use of the activator or functional type of mechanical treatment (Haupl, Grossmann, and Clarkson, 1952) or by the application of pressure to the anterior

surface of the mandible continually from an early age (Case, 1921).

It is possibly true, from the purely clinical point of view, that orthodontic treatment may not be relied on to produce changes in the shape of the facial skeleton large enough to contribute to the improvements that are found in occlusal relationships following treatment. However, to basc an orthodontic doctrine on the immutability of the basic face seems to be unwise in view of the evidence to the contrary, and also because such an approach is unduly limiting to thought.

The second part of the current doctrine, that which deals with the influence of the soft tissues of the face and tongue in determining tooth position, is one which is the subject of considerable discussion to-day.

It does not seem to be widely realized, and is certainly never taught, that the whole matter is almost as old as orthodontics itself and has been a subject of debate for many years. Not quite one hundred years ago Tomes (1873) said: "There is, I believe, no such thing as a natural tendency towards the assumption of the regular form in a dental arch; the physical forces at work, namely the lips and tongue, are amply sufficient to account for all the phenomena observed"; also, "Certain cases known as V-shaped contracted jaws likewise illustrate the power of the pressure of the lips and cheek to modify the position of the teeth".

From these early beginnings, the question of the relationship between the soft tissues of the face and mouth and the arrangement of the teeth has progressed through vicissitudes which vary from a virtual disregard of the soft tissues as factors of significance to their establishment as main factors in the causation of malocclusion. Brodie (1954) has suggested that "... the teeth once erupted are placed and held in an environment that is completely dominated by the muscular system". Ballard (1955) has maintained, that "the dental arches, whether normal or abnormal, were in a position that was in balance in soft-tissue morphology and behaviour"; and according to Hovell (1956), "In my opinion, the dento-alveolar structures should be regarded, like the muscular processes of bone, as being entirely moulded by soft-tissue action and morphology."

There seems now to be a tendency to regard such basic conclusions as beyond the need for further discussion, and later advances have been into the field of investigation into the actual origins of the various anomalies of muscular activity and the irregularities or malocclusions with which they are associated. The purpose of these investigations is to establish whether such activities are indulged in by patients consciously or actively as something they do for a reason they could explain and are therefore amenable to change at will, or whether such activities are totally unconscious and performed quite unawares as part of the patient's inherent neuromuscular make-up, and therefore unlikely to be alterable in the long term by any voluntary effort or mechanical or other orthodontic treatment.

It may still be allowed that the question of the influence of the soft tissues in determining tooth position is not altogether quite closed, and the continuation of research along a variety of lines is evidence that new attacks on the problem are being organized.

The question of balance between pressures of tongue and lips is one of the simpler problems, but here the approach is rather to find out what pressures the tongue and lips *can* exert experimentally rather than what they *do* exert in normal function, and the general conclusion has been that the tongue is a much more powerful pressure source than the lips and cheeks. Perston (1960) has been able to show that the excessive pressure of the tongue may be balanced where the teeth in the labial segment are concerned by the fact that the slope of the lingual surfaces of these teeth may, in effect, reduce the purely labial component of force and bring about a balance with the less powerful lip pressure.

With regard to the various kinds of tongue and lip activity and the occlusal anomalies with which they are associated, it is difficult clinically to collect appropriate kinds of cases in large numbers, exhibiting only the effect it is required to investigate. In orthodontics, the experimental material is in short supply and the practical difficulties for the clinician in

making a controlled investigation are enormous. As a result, conclusions have to be drawn from a wide variety of case types exhibiting many other kinds of anomalies such as overcrowding, loss of teeth, and various facial disproportions, so that the final conclusions are the summation of many subjective clinical impressions.

An attempt has been made by Walther (1960) to discover associations between soft-tissue factors and occlusal relationships by the method of survey of an untreated section of school population. This comprehensive investigation illustrates the difficulty in a group of material containing a large number of variables of making tests for significance of association, as apart from pointing out the existence of associations. The presence of so many variables makes it almost impossible to cstablish a clear-cut correlation to test for significance.

In addition to the kinds of investigation already mentioned, new aspects are being opened up of which the serial examination and recording of all recordable details on the lines suggested by Leighton (1960) seem to offer great possibilities, in that the rccords of not only the arrangement and function of the soft tissues are available, but also records of the developing occlusion, so that assessment and reassessment of the developing situation can be made not only by the original investigator but also by others on subsequent occasions. It is unlikely that the final answers will be found from any one source, and observation and comment from all angles bring new aspects to light. In concluding a report on "Lip Positions and Incisor Relationships" Jackson (1961) comments: "It has been found that an ideal incisor relationship is compatible with both competent and incompetent lip positions, some of the lip positions being grossly incompetent."

At present, doctrine regarding the significance of the relationship of the soft tissues to the position of teeth is based on the examination of cases in which there is established malocclusion and the precise developmental history of which is unknown. The basic conclusions are drawn from extreme examples of functional and occlusal anomaly and are applied to the lesser and more ill-defined degrees. The complications due to other possible factors are ignored, and in situations involving the simultaneous occurrence of a number of manifestations, cause and effect relationships are readily assumed.

We can therefore see that the theoretical approach to orthodontic problems by clinicians is distinguished by two main characteristics. First, the accumulation over a long period of time of a firm impression of the dominance of a few main factors in the dento-facial complex as determining tooth arrangement and the occlusal relationship, and secondly, the transmission in teaching of this conception as a foundation for the diagnosis and treatment of clinical conditions.

This approach to the organization of theory may be condemned as unjustifiably dogmatic, but in view of the difficulties of formulating orthodontic doctrine and the problems of the teacher in teaching a subject still in the relatively early stage of its development, the following observation is of unusual interest.

"Most students find that material which has no theme is unsatisfactory and it would appear justifiable in such a case to include a single hypothesis, or two contrasted hypotheses however unsuitable from an experimental point of view, rather than the jumble of guesses with which most oral problems are associated" (Wallis, 1961).

ORTHODONTIC RESEARCH

This heading is suggested as indicating investigations which do not necessarily come purely within the field of any one of the established biological sciences but which are aimed at the special problems of the form, development, and functioning of the facial structures and the dental apparatus. In this connexion two kinds of investigations may be distinguished.

First of all there is the investigation of clinical problems which seeks to establish their nature without attempting immediately to apply the results in orthodontic treatment. Work of this kind marks the entry by the orthodontist into the field of pure investigation for its own sake, regardless in the first instance of the possible practical applications.

Secondly, there is the clinical investigation, usually based on cephalometric analysis of malocclusion from which new principles of treatment may be evolved.

In 1926 Friel published the results of a long clinical and anthropological study of the normal development of the occlusion of the human teeth. This work, based on the examination of a diversity of individuals of various ages, presents in sum a conception of the way in which the human dentition develops from infancy to adulthood and matures through adulthood to old age.

As Friel has put it, "The description I have given you is an hypothesis of what I believe is the ideal state, based on the examination of a large number of specimens."

Although it was suggested that this conception of the development of the occlusion might be of value for reference in the estimation of the extent of irregularity and malocclusion at different stages, no attempt was made to indicate immediate practical utility, for instance in treatment. The basic conception, however, has remained unshaken for nearly forty years, and familiarity with it to-day makes it easy to overlook how great a contribution the concept of the development of normal occlusion is to the straightening out of orthodontic thought in many aspects of diagnosis and prognosis.

The work of Hellman (1948) in physical anthropology and in the study of facial growth and proportions in relation to orthodontic problems illustrates a rarely seen versatility in the clinical and scientific fields. The contributions of this author to the literature on these aspects of human development are voluminous and are a mine of information on many aspects of dento-facial proportions and the ontogenetic and phylogenetic development of the human dentition. Yet the name of Hellman has never been linked with any doctrine, much less a school of thought, that aimed to establish an approach to orthodontic treatment. Hellman left the findings of his work to speak for themselves where clinical applications were concerned, and it was clear that he did not wish to force a connexion between the clinic and the results of his purely scientific investigations. He appeared to regard the results of his investigations as giving some insight into the complex problems of the ontogenesis of the masticatory face, the application of which it was necessary to make with some caution.

When Broadbent (1937) developed cephalometric radiography in its present-day form, after some experimentation with various methods of registration, in due course a pattern of development of the facial outlines was produced embracing the age span from one month to adulthood, and it seems reasonable to say that this conception of the progress of facial growth corresponds for the face in many ways to the pattern of the development of the occlusion evolved by Friel.

So we can trace in the traditions of such early work a heritage of investigation primarily of a clinical nature, but carried out with strict regard to scientific principles of recording and analysis without particular reference to the clinical applicability of the findings. The work of Clinch (1938, 1951) and Bonnar (1956, 1960) in this country, and Baume (1950) and Moorrees (1959) in America, with reference to the development of the occlusion; of Smyth and Young (1932), Dockrell, Clinch, and Scott (1954), and Björk (1947) each in their different ways with reference to craniofacial proportionality, and of Lundström (1954, 1961) with reference to problems of craniofacial inheritance, bears witness to the cultivation of the field of clinical investigation for its own sake. Such work produces papers which make hard reading. There is no succulence in the form of a gallery of successfully treated cases to prove the soundness of a thesis. Attempts to link the findings of such work to clinical practice show clearly how wide is the gap between research and practice.

On the other hand, the literature is not lacking in investigations into craniofacial proportions and their relationship to the arrangement of the teeth; these investigations are usually based on X-ray cephalometric analysis. Such analyses usually lead to the development of a diagram or formula intended for the assessment of the sites of disproportion and to indicate possibilities for treatment.

So far, the meaning of craniofacial proportions in the detail planning of orthodontic treatment is obscure and the constant and varying attack on the problems contained in the subject is evidence of the difficulties that are involved. The fact that facial disproportion is reflected in occlusal malrelations is clear enough in the extreme instances of disharmony, but in the large groups made up of intermediate degrees of facial disproportion and associated occlusal disharmony, the designation of the origin of the trouble is a very difficult thing to do. The careful analysis of facial proportions in the population of these islands, purely as a fact-finding exercise, would be interesting and could hardly fail to be informative.

ORTHODONTICS AND BIOLOGY

As has already been mentioned, the problems of orthodontics have attracted the attention of people not primarily concerned with its clinical aspects—the attention of biologists—and this interest has often arisen in response to an approach by an orthodontist who recognized a connexion between his clinical problems and a wide variety of biological fields.

It is to be expected that co-operation and exchange of viewpoints in this way should lead to material advances in many aspects of purely orthodontic problems and it is interesting, therefore, to observe the expressed attitude of some biologists who have become interested in orthodontics to actual orthodontic problems as they have experienced them.

Krogman (1953), who has given much to anthropology and anatomy, the study of development and growth of children, and to the science and art of cephalometry, in discussing the relevance of these subjects to the problems of orthodontics, has given his point of view: "I have come to those problems as a growth student who for many years has been far more intrigued with, shall we say, the fundamental principles of growth development rather than the elaboration of those principles into a framework of thought that looks to their use in therapy. . . . I find limitations in my thinking in the latter direction because, not being a therapist, I am not aware of all of the final residual problems that exist in the adjustment between growth and treatment. I can go thus far in my thinking and you must meet me halfway to round out the picture."

It is not always that the difficulty of fitting general conclusions in subjects related to orthodontics to specific orthodontic problems is so clearly seen. Hooton (1946), in discussing the evolutionary tendency to retrogression of the face beneath the cranium culminating in the relatively retrognathous physiognomy of modern man, has given as his opinion: "In some measure modern malocclusion is encouraged, if not actually caused, by defective and arrested growth referable to improper diets, pathologic conditions in the nose and throat, or generally poor health that affects the whole organism. It is then clear that mechanical correction of malocclusions in a person whose whole physiology is subnormal or disturbed can be of little use."

This conclusion seems to presuppose that there is only one object of orthodontic treatment—to construct an ideal masticatory face where it did not previously exist—and that it is quite out of touch with the real aims of treatment and the possibilities that exist for treatment even in the very kind of physique and physiological make-up that has been described.

A rather different and more pungent assessment of the nature of orthodontic problems has been given in the crisp conclusion arrived at by Scott (1958) that "the only real complexity in orthodontics resides in the jargon and confusion of mind that orthodontists create for themselves". While it cannot be maintained that orthodontic terminology is internationally uniform and in all instances etymologically sound, this conclusion betrays an unawareness of the real nature of the clinical aspects of the problems of growth, development, and function as manifested in irregularity and malocclusion of the teeth in the living subject.

For the greater part, those who are interested in orthodontics as it were from outside, from the point of view of the bearing of their own subject on orthodontic problems, have stopped

short of the attempt to deal with specifically orthodontic questions.

Scott (1948), however, having done much to bring together apparently conflicting aspects of the study of the growth and development of the head, face, and dentition and added enormously to, if not established, present-day understanding of these processes, has carried the interpretation of growth and development from the anatomical point of view well into the clinical field.

In discussing the nature of the orthodontic problem, Scott (1959) has suggested: "In orthodontics, the fundamental problem is not one of the relationship between skeletal pattern and muscle action or even in the factors regulating facial growth . . . the proper question is, 'what is the relationship between bone growth and the growth of the tissue of the gums?' The answer lies at the junction of the alveolar bone and gum where the muco-periosteum is laying down the bone."

Now it was suggested by Brash (1924) that surface apposition, particularly at the alveolar borders, contributed much, if not the greater part, of the height of the jaws, and pointed out that alterations in the *direction* of alveolar growth would materially alter the form of the arch and the arrangement of the teeth, and in the upper arch, the height of the palate.

These interpretations are the application, in a limited area, of findings regarding one particular mode of growth of bone, but it would seem an over-simplification to lay the blame for many, if not most, malocclusions at the door of the alveolar bone. In the light of the analysis of cranial shape and its relationship to facial outline by Björk (1947) or even after the careful examination of children presenting at a morning's clinic for orthodontic diagnosis and treatment, it is difficult to escape the conclusion that deep-seated disproportions of the skull base and facial outlines underlie the final relationship of the dental arches in many cases, and it is unlikely that problems of malocclusion are attributable solely to the growth of the alveolar bone.

In attempting to elucidate the question of which factors contribute most to the final positioning and alinement of the teeth following eruption, Scott (1961a) again draws on the findings of the science of anatomy and applies them to the clinical field.

Discussing "the role of the soft tissues in determining normal and abnormal dental occlusion" this author suggests that "the thesis that normal dental arch form is determined by the forces exerted upon the teeth by the musculature of the tongue, lips, and cheeks is at the present time orthodox teaching and is more or less universally accepted". Apart from the fact that universality cannot be more or less but must be total, no evidence of inquiry is produced to support this statement. On the main question of how teeth come to their final positions in the dental arch, Scott inclines strongly to the view that bone growth and final form, including the bony form of the alveolar processes, are predetermined genetically, and that tooth eruption and dental arrangement are similarly controlled.

In support of these views he points out, "Before the teeth ever erupt, the alveolar processes of the maxilla and mandible, containing the developing teeth within the gum pads, have acquired a definite form", and suggests that this form is maintained as the teeth erupt and their crowns come to be between the soft tissues of the tongue and the lips and cheeks, and regardless of the influence of these soft tissues.

This conception seems to be based on the study of human fœtal or neonatal material and may possibly hold good as far as the deciduous dentition is concerned, where there is usually some degree of spacing of the teeth. If this concept, that the form of the alveolar processes foreshadows the arrangement of the teeth, were correct, much of the present understanding and teaching concerning the growth of the jaws and the development of the occlusion would need to be revised. The teeth of the permanent series develop in alveoli below the deciduous series and in a region well below the present or future alveolar processes. The successional dentition pre-eruptively enjoys an alveolar arrangement which resembles very little the future occlusal alinement. The crowded pre-eruption alinement of the permanent labial segments and their later

resolution in normal development is one of the marvels of the developmental process of the occlusion; space is made for the dental arch as development proceeds. The well-known and usually taught lingual position of the permanent latcral incisors alone would contradict the suggestion that tooth alinement is totally or mainly pre-eruptively determined.

While studies in comparative anatomy suggest that genetically determined positioning and movements of teeth occur, as for instanee in the procumbency of the incisors of the pig (Scott, 1961a) and in the rotations of the incisors of cattle (Brown, 1960), clinical experienee shows that in the human dentition, teeth apparently hopelessly placed, presumably genetically, if offered the pathway and the space into which to erupt, will frequently come into occlusion in spite of, rather than because of, their genetically determined prc-eruptive positions. This phenomenon ean be seen, for instance, when seeond premolars, inclined and impacted against an adjacent tooth, find their way into the line of occlusion.

While the formulation of orthodontie doetrine, from purely clinieal experienee, ean lead to over-simplification and the elaboration of explanations which may not be universally applieable, it seems equally true that the transplantation immediately to the clinical field of the conclusions of selected research may lead to eonclusions quite as debatable as any derived from clinieal observation. The gulf between scienee and praetiee is still wide and deep.

If this is indeed so, how should the connexion between science and practiee be regarded and how may future development of the connexion be encouraged?

The dogmatic teaching of orthodontic theory based on an empirical approaeh is unsatisfaetory in that it tends to lead to the transmission from generation to generation of hypotheses as proven fact, rather than to inculcate the habit of evaluating in the light of the student's own independent observations and experience any new ideas or coneeptions that may be presented.

There seems to be strong feeling to-day that a more seientifie attitude should be developed towards elinical problems, so that they can be diseussed and investigated in a more enlightened manner. It is suggested that there should be more and better teaching in basie seience subjects; that there should be integration of pre-clinical and elinieal teaching with the aim of giving an "all inclusive formative education upon which elinieal training would be built" (Rix, 1961). The basic question really is: Can a scientific outlook be achieved within the limits of the undergraduate course? Naturally enough, undergraduate education must be made as efficient and thorough as possible by adjustment of curriculum, improvement in teaching methods, and the devotion of teachers. The undergraduate course is, however, a vocational training for dentistry, and the seientifie outlook, for reasons of time, can only be inculcated by the enlightened teaching of the curriculum for dental training, much of which, as has been suggested, is of an empirical nature.

In the absence of any recognized and well-established tradition of clinical scienee in which to train the budding orthodontist, or dentist, the only way in which a thorough scientific training and outlook may be obtained is in a field in which a seientific tradition is well recognized and established, in which seientific qualifications may be obtained, and which is in a subject relevant to orthodontie or dental problems. By adopting a programme of this kind, certain objcctives can be aimed at.

In the first place, it should be hoped that those pursuing such a course would receive a basie training in the subjects which are being read; would learn an approach to researeh in these subjects; would earn a primary university degree in scienee, and have or acquire an interest in and an ability to pursue further research, given the necessary facilities. It is to be expected that he would also be able to excreise a critical faculty in relation to new ideas and conceptions in a wide but related variety of fields. Secondly, it would be expected that the relevanee to orthodontics of subjeet matter studied and investigated would be established or a positive effort would be made to show sueh relevanee.

It has been claimed by Scott (1960) that this system has been in operation for some time and has taken the form of making it possible

for "the average intelligent student", by breaking off his dental course for a year, to continue his basic science studies to a point where it is possible to obtain a degree in science. After this "these people can go out into the world and carry out research . . . it is simply a matter of putting them into an environment where biology is second nature and leaving them to themselves". It is claimed that this procedure is "a completely successful experiment". Such a claim is well justified if it is recognized that the aim has been to train research workers in the basic scientific subjects of anatomy, physiology, or biochemistry, or whatever branch of biology it may be. How far this approach goes to strengthen the links between basic science and orthodontic problems still remains to be worked out. For the present, the training of the undergraduate in science is aimed at producing greater enlightenment over the whole field of his dental outlook, but it seems that the ultimate aim would be to produce two streams in training and later work—the scientific and the clinical—the clinician, backed as it were by a scientific advisory service. As Scott sees it, "When one talks about co-operation between the clinician and the research worker, one means that the research worker goes to the clinician for his problems, decides which problem can in fact be tackled adequately and gets on with the job", and later "will present his findings in a paper which will not last more than fifteen minutes". There is, however, a basic flaw in the conception of such a partnership. Without some grasp of the meaning of scientific method the clinician would not be able to ask the right kind of questions, and the research worker, without adequate clinical experience, can never see the range, variety, and complexity of clinical problems through the eyes of the clinician in such a way as to decide which problem can be tackled adequately. Furthermore, while anatomy lies behind many orthodontic problems, it is presumptuous to suppose that it is basic to them all, and the range of specialist research workers that the orthodontic clinician would have to have at call under such a system would be quite large. The relevant subjects are highly developed and not under the command of a single researcher. It is possible that many of the questions that could be asked can only be answered in terms that are not clinically relevant as yet, but in order to make the most of those answers the research worker should have a valid understanding of the clinician's problems as he finds them in the clinic. The separation of "the potential research workers and teachers from the potential clinicians" at an early stage in dental training, as suggested by Scott (1961b), would certainly militate against the necessary understanding of one another's point of view.

There is reason to believe that when scientific training is given during the dental course, if the training is effective, it results in the production of research workers in basic science, not in clinicians with a scientific outlook. On the other hand, it is reasonable to think that the cultivation of the habits of research at postgraduate level, in combination with the understanding of the nature of clinical problems that results from experience, could be more effective in the development of a scientific clinical outlook.

In writing of the work of Hellman, Gregory (1948) has pointed out, "All Hellman's studies in the field of genetics, anthropology and evolution were originally motivated by his interest in orthodontics".

The subject of orthodontics provides in itself a strong stimulus in many people to probe deeper into the basic biological subjects related to it; the orthodontic literature bears witness to this fact. While the training of students at undergraduate level in biology up to degree standard can be successfully done, until practical experience is gained in orthodontics for a sufficient period the necessary links between science and practice cannot be made. There would seem to be a profitable field to cultivate in developing the scientific outlook in those who have already grappled with orthodontic conditions in the clinic and wish to attack their problems at a more basic level.

There would be practical difficulties in doing this, but it seems to be one of the best possibilities for strengthening the foundations of orthodontic theory and leading to further developments of it in the future.

In developing doctrine in orthodontics, perhaps the most important thing is a proper attitude. Too often, the attitude seems to be that from the start the problems are simple and that a few simple generalizations will solve the vast majority. Such an attitude is characteristic of those who have but a passing acquaintance with the subject or who wish to acquire no more than a passing acquaintance. It is too often the attitude of the student who wishes to learn what is required to pass an examination and it can be the attitude of the teacher who coaches him to pass it. Orthodontics offers a dominating interest on an intellectual plane and as such requires a lively and active curiosity in a wide field of subjects, not to mention the variable and ever-changing subject-matter of the clinic. Bertrand Russell (1923) has said, "The instinctive foundation of the intellectual life is curiosity.... If curiosity is to be fruitful, it must be associated with a certain technique for the acquisition of knowledge. There must be habits of observation, belief in the possibility of knowledge, patience and industry . . . and since curiosity is perpetually coming into conflict with other passions, there is need of certain intellectual virtues, such as open-mindedness." Future advances in orthodontic research, teaching, and practice must be guided by attitudes and principles such as these.

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DISCUSSION

Professor C. F. Ballard, opening the discussion, said that he thought members would agree that Mr. Adams had tackled a very difficult problem with his usual meticulous care and had given them a lot to think about. Early in his paper he mentioned the biological approach and suggested that much of what clinical orthodontists said had no biological foundation. Several medical educationalists, notably Tanner, had recently stressed that doctors

should be primarily applied human biologists. Professor Ballard contended that orthodontists were biologists—they studied living things, populations, and racial groups. From their observations they drew conclusions based on the analysis of large numbers of individuals and they formulated theories. Waddington suggested that the biologists saw man first as an animal: *Homo sapiens*. The orthodontist accepted this and evolved concepts which had increasing application to all branches of dentistry. There were two main groups of individuals who were opposed to such inevitable progress. The first were those clinicians who still believed that most abnormalities were environmental in origin. They did not understand that the basis of evolution was variation on which natural selection works. Furthermore, they did not appreciate that the gene pool in civilized populations was increased for at least two reasons: one was the greater mobility of peoples; the other was the increasing survival of the unfit.

It was to be expected, therefore, that civilized populations would show greater variation than that shown in populations more subject to the effects of natural selection.

The other group of individuals who opposed inevitable biological progress were those who did research in laboratories on pieces of dead or living organisms and then announced that the findings of others, concluded from observations on large numbers of complete individuals, could not be so.

From what he had said, it would be seen that he had a mild criticism of Mr. Adams's approach in presenting the pros and cons on certain points. Mr. Adams's statements from orthodontists' papers were taken out of context and without due recognition of the weight of evidence behind such statements. He then countered those statements by others from research workers who were not true biologists in the broadest sense. For example, with regard to the skeletal pattern, Mr. Adams quoted him as saying that the pattern did not change significantly. It was true that other workers, using lateral skull radiographs, had found small variations and he himself had qualified his statement with the word "significantly". Any change which could be seen occurring in the skeletal morphology of an individual was quite insignificant in relation to the orthodontic problem of any one individual.

Mr. Adams quoted Jackson (1961) as saying "it has been found that an ideal incisor relationship is compatible with both competent and incompetent lip positions, some of the lip positions being grossly incompetent". He could not understand the relevance of this, since neither Mr. Gwynne Evans nor he had ever suggested that lip incompetence was necessarily associated with a malocclusion. Most of the children which they had seen in an unselected sample had normal incisal relationships although many of them were grossly incompetent.

He entirely agreed with Mr. Adams about research. This must involve large unselected cross-sectional groups of the population or large numbers for longitudinal studies of growth and development. It needed large teams and long-term planning. It also needed money.

Finally, he had to comment on undergraduate and postgraduate education. He believed that a scientific or biological approach could and must be achieved in undergraduate training. Most of the techniques which made dentistry a vocational training must be handed over to ancillary workers. For dentistry to be a true university discipline, it had to be based on biological principles; it must begin with an understanding of all that was involved with present-day concepts of evolution and population genetics. That might involve the recruitment of an entirely different type of individual to the dental schools; individuals who by instinct and by training (both were involved) could understand the nature of man. Such a revolution had to come to teaching in all the university fields if man was to survive.

The President said that one of the functions of the opener of the discussion was to promote discussion and possibly, in so doing, to be a little contentious. Professor Ballard had got them off to a good start.

Mr. W. Russell Logan congratulated Mr. Adams on his most excellent discourse. He himself was a clinician, possibly one of the kind who were opposed to progress!

The great trouble in orthodontics was to keep one's feet on the ground; a lot of orthodontists' investigations had been done in a slightly air-borne condition. They tended to sit down and think things out in their heads, which was an absolute negation of scientific investigation.

The first thing in science was that one had to observe; one had to see something which could be demonstrated to others. The second thing was, having seen it, one must measure. If one could not measure it, one could not go on from there. That is where they had fallen down. They had not measured. They talked about the things they saw. One met in clinical examinations postgraduate students who described actions of soft tissues which he, personally, could not see. He was interested to notice that in Mr. Rix's Northcroft lecture he stated that he found himself in the same difficulty. The question was, were these phenomena really present?

As a clinician he had seen a man with a congenital facial palsy who never had any tone in the muscles on one side of the face and who had two perfectly formed dental arches.

He had been very interested to hear Mr. Adams refer to Hellman, one of the greatest scientific thinkers that dentistry ever had. He had worked a lot with Gregory, the anthropologist, from whom he learned the scientific outlook which many orthodontists had never achieved.

Mr. W. J. Tulley added his congratulations to Mr. Adams. It was given to very few pure scientists really to be able to see clinical problems; it was given to very few clinicians to be able to be scientific. People had got to be trained first clinically and then biologically in order to be able to carry out that sort of research work. Very few people were capable of seeing the clinical problem when they had a pure biological background.

Mr. Stephenson asked to what extent personal clinical assessment could ever be eliminated. In assessing field work and survey work, to what extent could instrumentation more accurately produce findings than those produced by personal and clinical assessment?

Mr. Adams, in reply, thanked Professor Ballard for opening the discussion and for his kind remarks. He did not feel qualified to say much about biology but it would be perverse to ignore the fact that although few orthodontists enjoyed the fruits of a formal training in biology, Professor Ballard had rightly pointed out that the problems they saw and tackled every day in the clinic were primarily biological and secondarily mechanical. It was only by placing the consideration of their problems in this order that orthodontists and orthodontics could progress.

Most teaching hospital units now had departments for the study of Clinical Science, each reflecting the scientific study of the clinical subject with which it is related. In such an organization there should at least be time and facilities for the study of complex clinical problems.

Professor Ballard had also put his finger on the spot in saying that research in orthodontics must take the form of longitudinal studies of large numbers in our population, and had pointed out some of the problems involved: the need for skilled and interested personnel, ancillary staff, the complexity of a really efficient organization, and the inevitably long time-span and cost of such survey projects.

There was still wide failure to recognize the basic difference between problems of variation leading to irregularities of the teeth in children who are otherwise normal, and the problem of the pathological processes of the teeth and face which may only be solved by operation, medication, or radiation.

The problems of variation in the cranium had already been studied extensively by the use of dried skull material, but the problem of orthodontics was to conduct such studies again on the living child with comparable accuracy, and this involved the problem of making and keeping proper standardized records so that the subject matter of investigation could be clearly defined and compared between observers and research centres. Mr. Adams agreed with Mr. Logan that until measurements could be made there would always be too much room for disagreements to arise. If one wanted to find out something, one had to have some idea about it beforehand. One's first idea might be belief, but until knowledge was assured, belief should be pointed out to be belief and not put forward as knowledge.

With regard to Jackson's paper, Mr. Adams said he had mentioned this to indicate the spreading of interest in problems concerning the soft tissues and to welcome new attempts to devise objective approaches to the problems presented by them.

Mr. Adams said he had suggested that it was difficult for one person to be both scientist and clinician and agreed with Mr. Tulley in this. There were exceptions, like the late Milo Hellman, who was withal modest in his claims and did not attempt to press his personality or attitude. It was possible for orthodontists to learn to be scientific; the problem was when to lay the scientific foundations so that a good balance was achieved between the scientific outlook and the realities of the clinical situation.

In reply to Mr. Stephenson, Mr. Adams said the question of the elimination of personal bias in observations interested him very much.

Where measurement was concerned, mathematical analysis could determine what the size of errors was and from what sources they came so that conclusions could be reached with accuracy. If a factor could be assessed by means of an instrument, this should be done rather than leave the assessment to personal judgement. If a factor could only be assessed by personal judgement, then the factor should be judged by two people a number of times and the proportion of times on which they agree or disagree worked out. A value in figures could then be given for the reliability of personal assessment.

REPORTS OF MEETINGS

ORDINARY MEETING, January 9

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, January 9, 1961, at 7.30 p.m. The President, Mr. S. Granger McCallin, occupied the Chair.

The Minutes of the Annual General Meeting held on Monday, December 12, 1960, were read by the Secretary, confirmed, and signed as a correct record.

Mr. G. D. Everard, whose election had been confirmed at a previous meeting, was introduced to the President and signed the Obligation Book.

The following candidates for election were admitted *en bloc* by a show of hands:—

Mr. G. T. Hutchinson, M.D.S., B.D.S. (Sydney), F.D.S., D.Orth. R.C.S. (Eng.), 111, Desborough Road, High Wycombe, Bucks.

Mr. B. B. J. Lovius, B.D.S. (Rand), F.D.S. R.C.S. (Edin.), F.D.S., D.Orth. R.C.S. (Eng.), Orthodontic Department, London Hospital, London, E.1.

Mr. B. H. Miller, B.D.S. (Rand), D.Orth. R.C.S. (Eng.), 11, Rutland Mews South, London, S.W.7.

Mr. J. E. Powell, B.D.S., L.D.S. (Manc.), 20, Chorley New Road, Bolton, Lancs.

Mr. L. E. Willis, B.D.S. (N.Z.), F.D.S., D.Orth. R.C.S. (Eng.), Dental Nurses' Training Hospital, Willis Street, Wellington, New Zealand. (Corresponding Membership.)

The President welcomed any visitors who might be present, and invited them to consider themselves as members for the evening. He added that, in the exercise of the prerogative which was open to him, there would be no discussion after his Address. However, he hoped that all present would enjoy the evening.

The President then gave his Presidential Address, on the subject:—

"*Extra-Oral Traction in Orthodontics*"

Mr. K. E. Pringle, in moving a vote of thanks to the President, said that he was sure that Mr. McCallin would bring to his office the elegance and good sense for which he was so well known to them all. To be the President of the British Society for the Study of Orthodontics was for an Englishman an acknowledgement of the high respect in which he was held by his colleagues. He knew that in the coming year their President wished the practice of orthodontics to be well to the fore. Their programme indicated that, and the President's Address, to which they had all listened with very great interest—it was for many of them a new approach—also showed the practical turn.

Without wishing in any way to suggest that the Address be discussed, he wondered whether he might ask Mr. McCallin to run over once more the technique of the headgear, for it was very important that they should all understand it fully.

In conclusion, he wished to assure the President that they all hoped he would have a very happy year of office.

The President, before closing the meeting, dealt briefly with the question raised by Mr. Pringle.

ORDINARY MEETING, February 13

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, February 13, 1961, at 7.30 p.m. The President, Mr. S. Granger McCallin, occupied the Chair.

The Minutes of the Ordinary Meeting, held on January 9, 1961, were read by the Secretary, confirmed, and signed by the President as a correct record.

The following candidates for election were admitted *en bloc* by a show of hands:—

Mr. T. P. Bass, B.D.S. (Lond.), Orthodontic Department, Royal Dental Hospital, Leicester Square, London, W.C.2.

Miss N. M. Coyle, L.D.S., B.D.S., Cholmeley Dene, Cholmeley Park, Highgate, London, N.6.

Mr. W. Stevenson, L.D.S. (Glas.), 125, Boness Road, Grangemouth, Stirlingshire.

Miss E. M. K. Pihl, L.D.S., S:t Clemensgatan 32, Hälsingborg, Sweden. (Corresponding Membership.)

The PRESIDENT said that he had been asked by the Council to remind members of the Country Mecting at Bournemouth. He hoped that members had already booked their accommodation and would bring their wives or husbands as was appropriate. They had a full programme of papers but there was room for one or two further demonstrations. If anyone had something they thought would be appropriate he hoped that they would hasten to let the Secretary know. He also hoped that they would reply to the notice which had been sent out as soon as possible to save the Secretary extra work.

He said that it was his pleasure to welcome any visitors who were present and to invite them to take part in the discussion which might ensue from the two papers to be given. He was very pleased to introduce Mr. E. S. Broadway, who would read Short Communications on "A Case of Congenital Facial Palsy" and "Some Cases of Resorption due to Impacted Upper Canines". As many of them would know, Mr. Broadway was the Consultant at the East Anglian Regional Hospital Board. He had talked to them before, and, on that account, he was sure they were looking forward to hearing what he had to say.

Mr. E. S. Broadway then read two short communications entitled:—

"*Resorption of Incisors due to Maldirecton of Eruption of Upper Canines*"

and

"*A Case of Congenital Facial Palsy*"

The PRESIDENT then welcomed Mr. J. H. Gardiner, who read a paper entitled:—

"*Supernumerary Teeth*"

ORDINARY MEETING, March 13

AN ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, March 13, 1961, at 7.30 p.m. The President, Mr. S. Granger McCallin, occupied the Chair.

The SECRETARY announced that an apology for absence had been received from Professor C. F. Ballard.

The Minutes of the Ordinary Meeting held on February 13, 1961, were read by the Secretary, were confirmed, and signed by the President as a correct record.

The PRESIDENT said that he had a very pleasant duty to perform. The Council had invited Mr. Harold Chapman and Mr. Harold Watkin to become Honorary Members of the Soeiety, and they had accepted. Neither of those two old friends needed any introduction to most people present. It was not long since Mr. Chapman was present at a meeting and it might interest those who had recently joined the Society to know that Mr. Chapman was President as long ago as 1925. He was not sure whether Mr. Chapman was a Founder Member of the Society; he thought he was. Mr. Chapman had been President again in 1952 and had been Honorary Secretary of the Society for fifteen years, which was a prodigious stint; he had been Treasurer for ten years. The President felt sure that their prcsent Treasurer, who had taken over from Mr. Chapman, had always felt that he eould go to Mr. Chapman for advice. Mr. Chapman's contributions to the Society had been numerous and frequent, and the President considered it to be a great honour to be in the Chair when he was elected to Honorary Membership.

Mr. Harold Watkin had been a friend to everyone for very many years. He had been President in 1933 and had always given the impression of being a man who had enjoyed his orthodontics. It was quite possible, had he decided to go into the field of engineering, that he would have been successful there, and, even now, he was full of new ideas and as interested as he eould possibly be in everything that was going on.

The PRESIDENT said he was told that he should ask members to elect Mr. Chapman and Mr. Watkin to Honorary Membership. He did not propose to do that but askcd them to join him in weleoming thcm as old friends and colleagues as Honorary Members of the British Soeiety for the Study of Orthodontics. (Applause.)

Mr. T. P. Bass, Mr. B. B. J. Lovius, Miss E. A. Mason, whose eleetion had been confirmed at a previous meeting, were introduced to the President and signed the Obligation Book.

The following candidates for election were admitted *en bloc* by a show of hands:—

Mr. B. S. Cryer, B.D.S., L.D.S., Loreto, Clamp Hill, Stanmore, Middlesex.

Mr. N. Norris, B.D.S., L.D.S. (Birm.), 62, Hodge Hill Common, Ward End, Birmingham 34.

Mr. H. S. Orton, B.D.S. (Bristol), L.D.S. R.C.S., 37, Cromwell Road, London, S.W.7.

Mr. D. W. Sarll, B.D.S. (Manc.), 146, Broad Street, Salford 6.

Mr. B. K. Chan, B.D.S., 90, Westbury Court, Clapham South, London, S.W.4. (Corresponding Membership.)

The PRESIDENT then welcomed any visitors and invited them to take part in the discussion.

Mr. H. L. LEECH then read his short communication:—

"*Angle's Class II, div* 1 *and Class II, div.* 2: *A Comparison of Stability after Treatment*"

The PRESIDENT then welcomed Mr. G. G. T. Fletcher, who delivered his paper:—

"*Anchorage Control in Space Closure*"

COUNTRY MEETING, May 5–6

The MAYOR OF BOURNEMOUTH welcomed members to the town. Although she knew little or nothing about orthodontics, she was particularly interested in young people. Her main theme for many years had been education and anything connected with young people. Naturally, she was interested in dentistry for young people. As a member of the Executive Committee of the National Health Service in Bournemouth, she was kept up to date with all that was happening. That morning, she had heard that the General Benefits Committee of the London Executive Council were considering a report by a subcommittee appointed by the Local Dental Committee; one of the recommendations contained in the report was that there should be periodic refresher courses in children's dentistry, and that orthodontics should be incorporated into the appointment. The report went on to say that what was wanted in future was a school service in which every dental officer took orthodontic cases.

She warmly welcomed that in Bournemouth, because they had only one gentleman who was at present dealing with an awful lot of work, and it was reassuring that someone else was alive to the problem.

The PRESIDENT thanked the Mayor for giving of her time to welcoming members.

(The Mayor then withdrew.)

The PRESIDENT welcomed members and said that he was sure they were going to have an interesting meeting.

The SECRETARY (Mr. B. C. Leighton) read the Minutes of the meeting held at Manson House on March 13, and they were confirmed and signed as a correct record.

The following candidates for election were admitted *en bloc* by a show of hands:—

Mr. W. N. McL. Niven, L.D.S. (U. St. And.), c/o Ministry of Health, 41, Tothill Street, London, S.E.1.

Mr. D. G. Watson, B.D.S. (W. Austr.), 102, Victoria Road, Springbourne, Bournemouth, Hants.

Mr. B. S. Cryer, Mr. H. S. Orton, and Mr. J. E. Powell, whose election had been confirmed at a previous meeting, were then introduced to the President and signed the Obligation Book.

The PRESIDENT said that, at the last meeting, they were honoured to welcome as Honorary Members Mr. Chapman and Mr. Watkin. On that occasion, Mr. Watkin was unable to be present but they were very happy to see him at the Country Meeting. He had come a very long way and had shown his usual enthusiasm for matters pertaining to the Society. They were very happy to see him. (Applause.)

Mr. H. G. WATKIN thanked the Society for the honour they had done him in making him an Honorary Member.

The PRESIDENT welcomed visitors and invited them to take part in the discussion as members.

Papers and demonstrations were then given, according to the following programme:—

Programme

Friday, May 5.

9.30 a.m. Paper: Mr. J. S. Rose: "*Variations in the Developmental Position of Unerupted Premolars*".

10.45 a.m. Coffee.

11.15 a.m. Paper: Professor C. F. Ballard: "*The Clinical Significance of Innate and Adaptive Postures and Motor Behaviour*".

12.45 p.m. Luncheon (Swiss Restaurant, Bourne Avenue).

2.15 p.m. Paper: Mr. D. A. Plint: "*A Method of Treating Class II, div.* 1 *Cases without using the Lower Arch for Anchorage or Traction*".

3.30 p.m. Tea.

3.45 p.m. Paper: Mr. W. J. Tulley: "*Long-term Orthodontic Results recorded by Cinephotography*".

7.45 p.m. for 8.15 p.m. Formal Dinner (Norfolk Hotel).

Saturday, May 6.

9.30 a.m. Paper: Mr. D. F. Glass: "*Congenital Suprabulbar Paresis*".

10.45 a.m. Coffee.

11.15 a.m. Paper: Mrs. M. E. H. Davis: "*The Treatment of a Case of Postnormal Occlusion*".

11.50 a.m. Paper: Mr. J. C. Stephenson: "*The Aetiology of Malocclusion*".

12.45 p.m. Luncheon (Swiss Restaurant, Bourne Avenue).

2.30 p.m. Table Demonstrations: Mr. C. P. Adams: "*Photography*". Mr. O. Harcourt Godfrey: "*Some Removable Appliances*". Mr. D. G. Gould: "*Construction and Uses of the Heath X Plate*". Mr. J. J. Hall, Mr. H. D. Astley-Hope, and Mr. G. A. Kerr: "*The Treatment of Crowding in the Lower Arch*". Mr. A. G. Huddart: "*Pre-surgical Dental Orthopædics*". Mr. D. G. Huggins: "*Some Methods of Rotating Teeth*". Mr. S. Granger McCallin: "*Cervical Traction*". Mr. D. Munns: "*The Extraction of Lower Incisors*". Mr. A. E. Parrott: "*Simple Clinical Photography*". Mr. N. J. Wood: "*Modifications of Appliance Design*".

3.30 p.m. Tea.

ORDINARY MEETING, October 9

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, October 9, 1961, at 7.30 p.m. The President was in the Chair.

The Minutes of the previous Ordinary Meeting were read by the Secretary, confirmed, and signed as a correct record.

The President welcomed visitors to the meeting and invited them to take part in the discussion or to ask questions, and to regard themselves as members for the evening.

Mr. J. S. Rose then presented a short communication:—

"*An Apparently Straightforward Case*"

The President then welcomed Mr. D. Greer Walker, who read his paper entitled:—

"*The Tooth, the Bone, and the Muscle*"

ORDINARY MEETING, November 13

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, November 13, 1961, at 7.30 p.m. The President, Mr. S. Granger McCallin, was in the Chair.

The Minutes of the previous meeting were read by the Secretary and signed by the President as a correct record.

Mr. W. N. McL. Niven, a new member, was introduced to the President, and signed the Obligation Book.

The following candidates for election were elected unanimously by a show of hands:—

Mrs. J. D. Manning, L.D.S. R.C.S. (Eng.), "Claysands", Pelham's Walk, Esher, Surrey.

Mrs. S. McDonald, L.D.S. (U. St. And.), 23, Pine Hill, Epsom, Surrey.

Mr. R. Hilton, L.D.S. (Manc.), 293, Windsor Road, Oldham, Lancs.

Mr. G. A. Noar, L.D.S. (U. L'pool), "Carisbrook", Knowsley Road, Whitefield, Manchester.

Corresponding Membership:—

Mr. Börje Billberg, Licensed Dental Surgeon, Avd. för Tandreglering Folkstandvärden, Halmstad, Sweden.

Dr. N. J. Cox, B.D.S. (Sydney), D.D.S. (N. Western), D.Orth. R.C.S., T & G Building, 201, Elizabeth Street, Sydney, Australia.

Dr. G. P. Copeland, D.D.S., M.Sc. (D) (U. Toronto), 58, Lisgar South, Sudbury, Ontario, Canada.

Dr. M. R. Lyn, D.D.S., 16, Tangerine Place Halfway Tree, Kingston 10, Jamaica, West Indies.

The President said that the main reason for the meeting was to listen to the Fifteenth Northcroft Memorial Lecture. The Society

honoured George Northcroft because he was one of the Founder Members. Indeed, as many of those present knew, he was possibly rather more than a Founder Member; he was the man who caused the orthodontists of the time to get together and form the Society. He was the Society's second President, in 1909, and was President again in 1929, twenty years later. He had been interested in orthodontics and practised orthodontics, but had wider interests in the dental world. Indeed, his influence was such that the British Dental Association had accorded him the honour of inviting him to be their President in 1915. It was unlikely that many of the members present knew Northcroft personally. He himself remembered being introduced to him, as a student, and a very charming individual he was. The Society was proud to be able to keep alive his name by honouring him with the lecture that was presently to be given.

Members would agree that it was fit that, on such occasions, the Society should invite someone pre-eminent in his own field to address them, and in Professor Kilner they had just that. As a young dental student, he could remember the impact that Professor Kilner's work had on the thinking at that time about surgery in cleft-palate problems. It was a fairly controversial period. Before that time, dental surgeons had tended to interest themselves in the repair of those abnormal palates, and Professor Kilner came along and discussed some of the things that were being done up to that time and made suggestions for the future. All those present were looking forward to hearing what he had to tell them.

Professor T. Pomfret Kilner then delivered the Fifteenth Northcroft Memorial Lecture, entitled:—

"*Cleft Lip and Palate Problems calling for 'Combined Operation' Attack*"

Mr. R. E. Rix, proposing a vote of thanks, said that he wished to take the opportunity of expressing his own thanks, and the thanks of the whole Society, to Professor Kilner, for presenting a most valuable Northcroft Memorial Lecture. It was seldom that members were able to listen to the fruits of such long experience and to have so distinguished a pioneer of plastic surgery to talk about a subject which had been a great problem to them. Professor Kilner, with his unrivalled experience, had helped them to see more light and had shown them a most valuable collection of excellent results of his lifetime's work. The Society was most grateful to him. He proposed a sincere vote of thanks to Professor Kilner for a most interesting lecture.

The vote of thanks was carried by acclamation.

ANNUAL GENERAL MEETING, December 11

The Annual General Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, December 11, 1961, at 7 p.m. The President, Mr. S. Granger McCallin, occupied the Chair.

Minutes.—The Chairman said that the Minutes of the last Annual General Meeting had been inadvertently read at the first meeting of the Society in 1961 and had been signed. He asked the Secretary to read them.

The Secretary, Mr. B. C. Leighton, read the Minutes.

Election of Officers and Councillors.—The Chairman said that there were no other nominations and he had therefore to announce that the officers and councillors for 1962 nominated by the Council, as printed on the agenda paper, with the exception of Professor Walther, were duly elected. He explained that Council had been out of order in proposing that Professor Walther should assume the duties of Curator as he had just completed his year as immediate Past President.

On behalf of the Council, he proposed that Mr. J. S. Beresford be asked to become Curator for 1962. This was *agreed.*

Election of Auditors.—Mr. D. T. Hartley proposed Mr. J. F. Pilbeam, a Past President of the Society, and Mr. Alan C. Campbell, who was well known as an orthodontic writer and a member of long standing. The motion was seconded and *carried.*

Report of the Treasurer.—The Treasurer (Mr. J. S. Beresford) said that before he presented his report, he would like to ask if the Society would wish the Hon. Secretary to write to Mr. S. B. Newton and Mr. T. L. Winn

thanking them for their services for more years than he could remember as Honorary Auditors of the Society. (*Agreed.*)

Presenting his report, he said that the Income and Expenditure account for the year to September 30 indicated an excess of Income over Expenditure of £542. Members were always very sympathetic towards the Hon. Treasurer whenever he was in financial difficulties and the books showed a deficit. There was generally criticism if there appeared to be excess profits. In the past, it had been suggested that the Society should be more adventurous regarding the Society's Publications and perhaps bring out an Orthodontic Journal. It seemed to him that the employment of some form of salaried secretarial staff by the Society was now overdue. Movement in either of those directions would quickly absorb the present excess of income and make demands upon the reserves.

The costs of reporting were greater because of the increased activity when there was a Country Meeting.

He apologized if the item under "Publications" appeared misleading. In the Income and Expenditure account, an endeavour was always made to indicate the actual cost of Publications and Transactions as distinct from the estimate of the reserves shown on the Balance Sheet. The £678 7s. 1d. referred to the cost of Publications including the 1959 *Transactions.* As Members knew, the 1960 *Transactions* were not yet published. Accordingly, in the Balance Sheet would be found reserves for the *Transactions* for 1960 and for 1961.

In the Income and Expenditure account, an increase in the depreciation of furniture and equipment would be noted. The accountants had advised that in the past the amounts written off for depreciation had been a little unrealistic.

Since the end of the financial year, there had been some changes in the Society's investments. After consultation with brokers, the undated Consolidated Stock ($2\frac{1}{2}$ per cent and 4 per cent) was sold.

The Council felt that advantage should be taken of the change in the law permitting the purchase of Equity Stocks. An investment of just under £1000 had been made, divided between City of London Real Property and Royal Insurance Company. Those might be described as "growth stocks" with a low dividend rate.

Approximately £500 had been invested in each of J. & P. Coates, Patons & Baldwins Ltd., and British Insulated Callender's Cables Ltd. Those two stocks offered a higher yield comparable with that obtained from the existing gilt-edged securities.

He was again grateful to the Honorary Librarian for a large contribution to the income from the sales of *Transactions.*

As it was his tenth and last report, he wished to record his thanks to the accountants and to the Honorary Auditors who always provided him with much help and who completed their work so promptly every year in order that the accounts might reach the printers in time.

He was especially grateful to the Society's bankers who received no fee for keeping the Society's account. They were always ready to help in tracing an obscure subscription and to give advice, whenever a change in the Society's investments was contemplated.

On the motion of the HONORARY TREASURER, seconded by Professor D. P. WALTHER, the report was *received.*

There was no discussion and a motion by the PRESIDENT from the Chair that the report be adopted was *carried.*

Report of the Secretary.—The SECRETARY (Mr. B. C. LEIGHTON) presented his report. He said that he had once again to report an increase in the Society's membership. It now stood at 500 Ordinary Members and Corresponding Members. During the year, 20 members had resigned and 34 members had been elected. The average attendance at each meeting had now risen to 107. This activity, which must reflect a growing enthusiasm for orthodontics, was to be welcomed by all. The Council, however, had felt for some time a little disturbed by the weight of work which it involved, particularly for the Officers of the Society. There had been set up, therefore, a Sub-Committee to investigate the problem;

it had already met once and would be reporting to the Council soon.

The climax of the year was, perhaps, the Country Meeting. It had been held at Bournemouth, which was a departure from practice in previous years of holding it in the precincts of a University. The popularity of the experiment was acclaimed by the number of members who attended—127. The seriousness of the Meeting had been lightened by a formal dinner which was as well attended as the meetings.

By and large the year had been one of progress, and would be remembered for several innovations.

On the motion of Mr. LEIGHTON, seconded by Mr. J. S. ROSE, the report was *received.*

On the motion of the PRESIDENT, the report was *adopted.*

Report of the Editor.—The HONORARY EDITOR (Mr. W. J. TULLEY), presenting his report, said that during the past year the Society had enjoyed the usual excellent liaison with Messrs. John Wright & Sons Ltd. The Chairman, Mr. John Wright, had recently died while still in harness, at well over eighty.

The publication of the *Transactions* for the previous year was again delayed although it would take place any day. The delay in publication of *Transactions* and individual papers was due mainly to the large volume of material in individual papers and to the number of papers, because of the Country Meeting. It had been necessary to edit the discussions fairly strongly; in some instances, they would otherwise have exceeded the length of the paper! That had, however, only been done as a last resort when they would not fit in with the pages allotted to them.

On the motion of Mr. TULLEY, seconded by Mr. HOWARD, the report was *received.*

The PRESIDENT, moving the adoption of the report, said that it was surprising to him that all that hard work was not the cause of any discussion. The report was *adopted.*

Report of the Librarian.—The HONORARY LIBRARIAN (Mr. D. I. SMITH), presenting his report, said that there had been an increase in the demand for the Society's *Transactions.* During the past year, copies had been sold to libraries and non-members in all parts of the world. It had not always been possible to supply past numbers of the *Transactions*, and he would be pleased to accept, on behalf of the Society, any copies which were no longer required.

The following books had been purchased: *Introduction to Orthodontics* edited by A. Lundström; *Orthodontia in Everyday Practice* by R. Hotz; *Malformations of the Face* by D. Greer Walker. The Library was still housed in the Institute of Public Health and was now developing a problem of overcrowding.

On the motion of Mr. D. I. SMITH, seconded by Mr. J. S. BERESFORD, the report was *received.*

Mr. C. P. ADAMS said that the matter of shortage of volumes of past *Transactions* was a matter that was near to his heart, because of the tendency for those volumes to disappear from departmental libraries and private possession. He wondered if there would be any possibility of the Society preparing microfilms of them, particularly past volumes, so that they could be kept and supplied to anyone who wanted them. It was not very difficult to do.

The CHAIRMAN said that the suggestion seemed to be an interesting one.

Mr. D. T. HARTLEY said that if there was general agreement that something of that nature was desirable, Mr. Adams would probably agree that reproduction by the process known as Xerography might enable the Society actually to sell reproductions of the old *Transactions.*

The CHAIRMAN said that Council would take note of the suggestion.

On the motion of the Chairman, the report was *adopted.*

Report of the Curator.—The HONORARY CURATOR (Dr. J. R. E. MILLS), presenting his report, said that the museum was still housed in the Institute of Public Health, 28, Portland Place, where it might be visited on weekdays between 10 a.m. and 5 p.m.

Its exhibits included a collection of serial models of developing occlusions which was among the best in the world. The CURATOR would be pleased to receive more serial models

and especially serial radiographs of developing occlusions.

During the year the museum had received models and radiographs of a case of depressed permanent molars presented by Mr. M. L. Brenchley.

Dr. L. M. Clinch had presented a display cabinet to the museum to house the Society's unique series of serial face masks. During her period as Curator, Dr. Clinch also presented numerous exhibits to the museum, which had not previously been acknowledged.

On the motion of Dr. J. R. E. MILLS, seconded by Mr. BROADWAY, the report was *received*.

Mr. C. P. ADAMS asked if there was any possibility of some kind of list or catalogue of the material in the museum being prepared and circulated to members on request, so that if people wished to make use of the material, they would know what to look for.

Dr. J. R. E. MILLS said that that would be a matter for his successor. There was a catalogue; Dr. Clinch had spent a great deal of time cataloguing the exhibits in the museum and the catalogue was available for inspection. Whether it should be duplicated and sent to everyone was a matter which would have to be considered. It would be expensive.

The CHAIRMAN said that the Council would make a note of the suggestion and find out exactly what existed in the way of a list. They could then consider whether any useful purpose would be served by circulating it to members. He moved the adoption of the report. The report was *adopted*.

The First Chapman Prize.—The CHAIRMAN announced that the winner of the First Chapman Prize was Mr. D. A. DIXON for his essay, "*Observations on Submerging Deciduous Molars*". Three members had entered. They looked forward to hearing Mr. Dixon's essay, which would be presented as a paper at the October Meeting.

Mr. J. S. BERESFORD referred to the cup which was on show at the Meeting and asked the President to explain what it was. It was inscribed "B.S.S.O. President's Cup, presented by S. Granger McCallin, 1961".

The CHAIRMAN said that, as many members knew, an informal golf meeting had been held during the Country Meeting at Bournemouth. Those who had taken part had enjoyed themselves on a perfectly vile afternoon, and suggested that it should be continued in future years. The Council had been kind enough to accept the trophy on behalf of the members and he hoped that many members would compete for it, and that, as time went on, there would be some proper rules and regulations so that everyone knew what they were playing for. He hoped members would be willing to accept the trophy. (Applause.)

The proceedings of the Annual General Meeting then terminated, and guests and visitors were then admitted.

ORDINARY MEETING

The SECRETARY read the minutes of the last Ordinary Meeting and these were confirmed and signed.

The following Ordinary Members were elected:—

Mr. S. KLYNMAN, L.D.S. R.C.S. (Eng.), 957, London Road, Leigh-on-Sea, Essex.

Mr. P. M. Benzies, B.D.S., L.D.S. (U. Sheff.), D.D.O. R.F.P.S. (Glas.), D.Orth. R.C.S. (Eng.), 1, Crediton Hill, London, N.W.6.

The CHAIRMAN welcomed visitors and asked them to consider themselves members for the evening and to take part in any discussion of the paper if they so desired.

Introducing Mr. C. P. ADAMS, he said that he was lecturer in Orthodontics at Queen's University, Belfast, and had talked to members on many previous occasions. His paper was entitled "*Orthodontic Theory To-day*", and members would doubtless be very interested in what he had to tell them.

Mr. C. P. ADAMS then presented the following paper:—

"*Orthodontic Theory To-day*"

The CHAIRMAN thanked Mr. Adams.

PRESIDENT'S VALEDICTORY ADDRESS

He said that it fell to him to give up his position and introduce the new President. It would not be right for him to step down without expressing his appreciation and members'

appreciation to the officers of the Society and the Council for the work they had done during the past year. Two of the Society's principal officers were handing over their portfolios after holding them for a fairly extended period. The two Jacks, Beresford and Tulley, had discharged their responsibilities with distinction and the Society could not help but be grateful to them. Jack Beresford had been the Treasurer for ten years and it was true to say that the finances of the Society were in a fairly buoyant state; that was undoubtedly due to him.

He himself had sat on the Council for the last few years and as new members had come on the Council, all full of fire and interest in what was going on, they had immediately gone for him on financial matters. Mr. Beresford had always handled the situation with aplomb and good humour. He had always got a ready answer and very soon the new members came to respect him and did not cross swords with him. The Society was grateful to him; he had done a tremendous job.

Mr. Tulley was handing over his responsibilities as Editor. One of his functions was to edit; fortunately for members, he had edited: what he had done to some of the discussions that had taken place would surprise them. However, his efforts had gone to the production of the *Transactions* which was, in a way, the item which the Society produced every year which showed thc image that the Society had in dentistry in this country; the success with which Mr. Tulley had put the *Transactions* together and handled that particularly difficult job was obvious to everyone. His respite from office would not be long but he would appreciate it. Members would want him to know how much they all owed him for what he had done.

It was traditional, at that point, to make some nice remarks about the Secretary. He was the linchpin around which the whole Society revolved. It had become increasingly apparent, as the membership increased, that his job had just about reached saturation point. In fact, so obvious had it become that the Council was considering ways and means of trying to help him and, indeed, some of the other officers; but he had soldiered on and he would soldier on. It would take a little time for those things to materialize. He might not have assistance next year but it was being thought about and he hoped Mr. Leighton would continue to give the tremendous amount of his time that he did to the Society's business. If they could see the volumes of material he produced, they would be staggered. The Chairman thanked the whole Council, who had worked hard and long on the Society's behalf, often niissing their supper in the process.

They were losing those three old stalwarts from the Council: Professor Walther, Mr. Hartley, and Mr. Leech. They had all contributed, and the Council were sorry they were leaving.

Finally, before asking the new President to come up, he said that, as Chairman, he had often wondered whether the Society was in good heart. Orthodontics was becoming much more widely considered. There was a tremendous interest in it, which was increasing every year. Members believed that good orthodontics was the foundation of good dental health and of good dentistry. A good basic education on the lines that some of the speakers had described was absolutely essential to orthodontics. He wondered sometimes whether the Society was doing all it should; he thought it probably was. They carried on with their meetings, as their Founders had laid it down that they should. Probably that was all they were called upon to do. The Country Meeting had opened up a new field for those members who could not get to London, but one wondered if there were possibly pockets of interested orthodontists or general practitioner orthodontists in various parts of the country which were not covered. He wondered whether some of those people had thought of gathering together in study groups, and if they did, he was sure those in London would be glad to hear from them and help them in any way possible. Numbers of people had formed such groups outside the Society, but there were areas which were not well covered.

One of the things he had discovered was that the President was called upon to close the Ordinary Meetings of the Society at ten o'clock.

They still had a little time. They had all had a fairly busy evening, and with those final thoughts, he had pleasure in asking Mr. Logan to come to the platform. Mr. Logan, as members knew, came from Edinburgh. He was a Scotsman, and in honouring him, the Society sought to honour Scotland. It was a long time since the Society had had a Scottish President and it was a great pleasure to look forward to having one. Mr. Logan had a difficult task and had a long way to go and a lot of travelling to do. The Society should be very grateful to him for being prepared to undertake the assignment.

He asked Mr. Logan to come up so that he could invest him with the badge of office.

He handed over the chain of office to the new President.

Vote of Thanks to the Retiring President.—Mr. J. S. Rose, proposing the vote of thanks to the retiring President, said that Mr. Granger McCallin was the sort of person who liked to do a job, do it quietly, efficiently, and effectively. That was just what he had done during his year of office. All members would have seen that in the way that the meetings had been run and would have noticed it in the way the Country Meeting at Bournemouth was run. Very few would know that, for the Country Meeting, he personally had gone down to Bournemouth to supervise many of the arrangements.

In the Council, he had listened patiently to the opinions of the members and had shrewdly and wisely summed up.

He was glad that the Constitution of the Society demanded that the retiring President stayed on the Council for the following year, because Mr. McCallin's advice was always very valuable.

To say more would embarrass Mr. McCallin and he therefore proposed a very hearty vote of thanks to the retiring President.

The vote of thanks was carried by acclamation.

The President (Mr. W. Russell Logan) said that he considered that a great honour had been done to him by the Society in electing him President. He had been a member for a long time, and he knew that the British Society for the Study of Orthodontics had done a lot for orthodontics; it still had to do a lot in the time to come.

Mr. Granger McCallin was a difficult President to follow. The first duty of the President was to direct the deliberations of the Council, and that Mr. McCallin had done with a firm and resolute hand. He only hoped he might be able to manage them as well, but he doubted it.

It remained only for him to close the meeting by announcing that the Presidential Address would be delivered on Monday, January 8, at 7.30 p.m. The subject would be a clinical one: "*The Effect of the Milwaukee Brace on the Developing Dentition*".

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

Balance Sheet and
Income and Expenditure Account

FOR THE YEAR ENDING SEPTEMBER 30, 1961

FREDK. B. SMART & COMPANY, CHARTERED ACCOUNTANTS
22 Queen Street, London E.C.4

The British Society for the Study of Orthodontics

INCOME AND EXPENDITURE ACCOUNT for the year ended 30th September, 1961

1960									1960								
£	£			£	s.	d.	£	s.	d.	£	£			£	s.	d.	£	s.	d.
11		To *Museum Rent*					10	10	0			By *Members' Subscriptions:*—							
		,, *Meeting Expenses:*—									1,452	1961 Subscriptions		1,461	15	10			
	54	Hire of Hall		46	13	0					36	Arrears Collected		64	18	7			
	83	Refreshments		68	5	0				1,488	—						1,526	14	5
	47	Reporting		98	12	9				142		,, *Sale of Transactions*					157	14	10
	6	Lantern and Films		5	0	0						,, *Interest Received and Accrued:*—							
	—	(Country Meeting)		29	13	0					—	Savings Certificates		31	13	4			
	26	Northcroft Memorial Lecture		26	5	0					17	2½% Consolidated Stock ..		17	5	4			
216	—						274	8	9		20	4% Consolidated Stock ..		20	0	0			
		,, *Printing:*—									19	5¼% Hertfordshire C.C. Stock (net)		19	5	10			
	1,493	Publications (including Transactions 1961)		678	7	1					16	5¼% Corporation of London Stock (net)		16	1	8			
	115	General Printing and Stationery		158	6	1					11	3% Funding Stock		21	13	8			
1,608	—						836	13	1		12	5% Defence Bonds		50	0	0			
15		,, *Library and Journals*					2	17	6		10	3½% Defence Bonds ..		—	—	—			
66		,, *Postage*					52	3	2		27	Post Office Savings Bank ..		15	10	4			
23		,, *Honoraria*					23	2	0	132	—						191	10	2
26		,, *Accountancy*					26	5	0			,, *Income Tax recoverable* to 5th April 1961					36	1	10
4		,, *Insurance*					4	3	6	22									
10		,, *Sundry Expenses*					2	11	2			,, *Excess of Expenditure over Income for the year*							
		,, *Depreciation* of Furniture and								229							—	—	—
34		Equipment					136	17	6										
		,, *Excess of Income over Expenditure for the year*					542	9	7										
£2,013							£1,912	1	3	£2,013							£1,912	1	3

The British Society for the Study of Orthodontics

BALANCE SHEET as at 30th September, 1961

1960 £		£ s. d.	£ s. d.
	Accumulated Fund:—		
	Balance at 1st October, 1960	4,417 5 3	
	Add: Excess of Income over Expenditure for the year	542 9 7	
4,417			4,959 14 10
	Creditors and Reserves:—		
	Publications printing reserves (estimated		
1,700	by the Hon. Treasurer)	1,700 0 0	
26	Northcroft Memorial Lecture	26 5 0	
13	Hire of Hall	13 10 0	
10	Museum Rent	9 12 6	
13	Subscriptions in advance	22 11 6	
4	Hon. Secretary Petty Cash Account ..	4 18 8	
26	Accountancy	26 5 0	
			1,803 2 8
£6,209			£6,762 17 6

1960 £		£ s. d.	£ s. d.
	Furniture and Equipment:—		
	Balance at 1st October, 1960	234 5 0	
	Add: Additions during year	53 8 6	
		287 13 6	
	Less Depreciation	136 17 7	
234			150 16 0
	Investments at Cost:—		
	1,200 National Savings Certificates plus		
928	accrued interest	959 3 4	
576	£691 5s. 10d. 2½% Consolidated Stock	575 14 0	
485	£500 4% Consolidated Stock	485 6 3	
1,000	£1,180 3% Funding Stock 1959/69 ..	1,000 5 0	
1,000	£1,000 5% Defence Bonds	1,000 0 0	
	£600 5¼% Hertfordshire County Council		
597	1965	597 9 6	
	£500 5¼% Corporation of London		
509	1976/79	508 10 9	
	(Approximate Market Value £4,689)		5,126 8 10
22	*Income Tax Recoverable*		36 1 10
	Cash at Bank:—		
400	Westminster Bank Ltd.	478 15 7	
455	Post Office Savings Bank	970 3 7	
			1,448 19 2
	Cash in Hand:—		
3	Honorary Treasurer		11 8
£6,209			£6,762 17 6

S. B. NEWTON, T. L. WINN } *Hon. Auditors*
J. S. BERESFORD, *Hon. Treasurer*

Certified in accordance with the Books and Vouchers of the Society.
We have verified the Investments and Cash at Bank.
FREDK. B. SMART & CO.,
Chartered Accountants,
22, Queen Street, London, E.C.4.

8th November, 1961.

SUBJECT INDEX

AUTHOR INDEX